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Greenhouse and Nursery Series

Growing Media for Container Production in a Greenhouse or Nursery

Part I – Components and Mixes

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Introduction

Successful greenhouse and nursery production of container-grown plants is largely dependent on the chemical and physical properties of the growing media. An ideal potting medium should be free of weeds and diseases, heavy enough to avoid frequent tipping over and yet light enough to facilitate handling and shipping. The media should also be well drained and yet retain sufficient water to reduce the frequency of watering. Other parameters to consider include cost, availability, consistency between batches and stability in the media over time.

Selection of the proper media components is critical to the successful production of plants.

Media Components – Organic Amendments

Peat

Peat is a very common component in both nursery and greenhouse mixes. Peat is usually included in a mix to increase the water-holding capacity or to decrease the weight.

Peats used in horticulture are usually classified into three types: moss peat, reed-sedge and peat humus. Moss peat, more often called peat moss, is the most common form used in the industry and is derived mostly from sphagnum moss.

Peat moss, the least decomposed form of the peat types, is typically light tan to brown in color, lightweight (6.5 lbs/yd^3), high in moisture-holding capacity and very acid (pH 3.8 to 4.3). A significant problem with peat moss is "wetting up." Peat moss is inherently hydrophobic (repels water). To address this situation, some suppliers offer a product with a wetting agent already included.

Super bales of peat.

Before using peat moss, you should conduct a simple test to see how difficult the product will be to wet. If the product does not include a wetting agent, you can incorporate one, or use hot water if available, to speed up the wetting process. Peat moss is typically sold in compressed bales that expand 50% to 100% when properly fluffed. Most recipes call for peat moss on a volume basis (e.g., 50% peat moss:50% perlite, vol:vol).

Sphagnum moss differs from moss peat (peat moss) in that it is the young residue or live portion of the plant. Sphagnum, or "top moss," is commonly used for plant shipment, propagation or to line hanging baskets. Substances have been extracted from sphagnum peat which inhibit the growth of fungi associated with damping off.

Reed-sedge peat is formed principally from reeds, sedges, marsh grasses, cattails and other associated swamp plants and is widely used in Florida. **Peat humus** is usually derived from reed-sedge or hypnum moss peat and represents an advanced stage of decomposition. This type of peat is usually dark brown to black and has a low moisture-retention capacity.

Coir (Coconut Fiber)

Coir is a relatively new organic amendment primarily used in the greenhouse industry. It has been suggested as a potential substitute for peat moss. The raw material, which looks like sphagnum peat but is more granular, is derived from the husk of the coconut fruit and originates from several countries including Sri Lanka, India, Philippines, Mexico and Costa Rica. Because it originates from such diverse geographic locations, it is difficult to characterize specific chemical and physical properties. Based on current data, growers should be most concerned about the total soluble salts (electrical conductivity), sodium and chloride levels in their coir product before making a wholesale switch to this organic substrate. The typical pH range for coir is 5.5 to 6.8, and the average dry bulk density is 4 lbs/ft^3. It contains significant amounts of phosphorus (6 to 60 ppm) and potassium (170 to 600 ppm) and can hold up to nine times its weight in water. Since coir contains more lignin and less cellulose than peat, it is more resistant to microbial breakdown and, therefore, may shrink less. Coir is easier to re-wet after drying than peat moss.

'Bricks' of coir which will be broken up before use in a container substrate. The strands of coconut fiber are visible in the 'brick.'

Softwood Bark

Bark is the primary component (80% to 100% by volume) in most outdoor container nursery mixes. For many years, bark was viewed as a forest waste product, but today the availability for container use is limited in some markets due to alternative demands (e.g., landscape mulch, fuel) and reduced timber production.

Pine bark is preferred over hardwood bark since it resists decomposition and contains fewer leachable organic acids. Pine bark is usually stripped from the trees, milled and then screened into various sizes. A good potting medium usually consists of 70% to 80% (by volume) of the particles in the $^1/_{42}$- to $^3/_8$-inch range with the remaining particles less than $^1/_{42}$ inch.

Bark is described as either fresh, aged or composted. Many growers use fresh bark but typically add 1 lb N/yd^3 to compensate for the potential nitrogen draft that occurs in the pot. Composting bark involves moistening the bark, adding 1 to 2 pounds N/yd^3 from either calcium nitrate or ammonium nitrate, forming a pile and then turning the pile every 2 to 4 weeks to ensure proper aeration. Composting bark typically takes 5 to 7 weeks. Aging is a cheaper process, but aged bark has less humus and a greater nitrogen draw-down in the container than composted bark.

Hardwood Bark

The chemical properties of hardwood bark are significantly different from pine bark. The pH of fresh hardwood bark is usually less acid (pH 5 to 5.5) than peat moss or pine bark. Composted bark may be rather alkaline (pH = 7 to 8.5). Hardwood bark typically contains toxic compounds and, for this reason, should be composted before use.

According to the University of Illinois, for each cubic yard of bark, a grower should add 2 to 3 pounds of actual nitrogen, 5 pounds of superphosphate, 1 pound of elemental sulfur and 1 pound of iron sulfate. These amendments should be blended into the bark and some water added to the blended pile. Turning the pile three to five times during the 60-day process is recommended to get a uniform product. The temperature in the pile should approach 150°F to eliminate most pathogens.

Wood Substrates

Historically, wood-based substrates have been avoided due to concerns about nitrogen draft. More recently, wood-based amendments have been successfully tested as a renewable alternative for pine bark in the nursery industry and peat moss and perlite in the greenhouse industry. Since 2005, more research has been conducted on the use of wood-based components than any other alternative material.

Research on the nursery side has focused on 'debarked loblolly pine logs' (majority wood; sometimes referred to as 'pine tree substrates,' PTS) and 'whole-tree' (containing all shoot proportions of the tree and thus consisting of approximately 80% wood fiber; sometimes referred to as 'whole-tree substrates,' WT and 'clean chip residual,' CCR) processed into container substrates. Many studies have shown that the growth of numerous woody and herbaceous plants using wood-based

Processed 'clean chip residual' (CCR) which will be used in a greenhouse substrate.

substrates is comparable to 100% pine bark (PB), however, the percent of wood product, particle sizing, fertilizer rate and type of crop (i.e., short or long term) will need to be strongly considered to achieve favorable results. According to Dr. Brian Jackson at North Carolina State University, there are a few things to consider when using wood in a nursery substrate including: 1) incorporation of less than 40% typically does not change many production practices in regards to fertility and irrigation, 2) loblolly pine is the best tree species for use, not hardwoods, 3) substrates containing wood will break down over time, as does pine bark, 4) increased pH is often observed when higher percentages of wood are used and 5) substrate drainage and drying properties will likely be different than 100% PB.

Currently (2018) there is greater adoption on the greenhouse side for wood-based amendments than on the nursery side largely due to the current raw material costs of peat moss and perlite. Research has shown that when pine wood **chips** are used as a substitute for perlite at rates up to 30% in a peat substrate there is no need to change cultural production practices. No differences were found in nitrogen use, liming requirement or plant growth regulator efficacy. These results should not be applied or assumed for other wood components!

The use of wood products as an ‘extender’ or ‘alternative’ started in Europe in the late 1980s and made it to the U.S. in 2004. Current efforts are centered on using wood fiber as an amendment to peat moss in the range of 10% to 40%. Several commercial substrate companies offer blends using wood fiber. An example would be Berger’s ‘natural fiber’ (NF) series.

New substrate fractioning and reconstruction techniques have been recently identified and studied to decrease weight/density and allow substrate manufacturers to ‘design and build’ (engineer) substrates for specific purposes.

Compost and Animal Manures

A large variety of compost or animal manure products is available in the marketplace. This section will highlight several considerations when evaluating these materials as a media amendment.

Manures: Disadvantages include possible high salts, fine particle size and weed seeds. The advantages include the nutrient contribution and potential improvement in media physical properties.

Sludge: A primary consideration when evaluating a sludge is the potential for elevated heavy metals including cadmium, lead, zinc, copper and mercury.

Plant-based composts: In some areas compost products provide a low-cost media amendment. Critical issues to consider are the availability and consistency of the product and the particle size. Particle sizes for plant-based compost can be either too large or too fine depending on the source material and composting process.

Rice Hulls

Parboiled fresh rice hulls.

Arkansas growers are fortunate in that this organic component is readily available as a result of the sizeable rice industry in the Delta. Rice hulls are available in a variety of forms including fresh, aged, carbonized, composted and parboiled. **Fresh** rice hulls are typically avoided as container substrates because of residual rice and/or weed seed. Parboiled rice hulls (PRH) are produced by steaming and drying rice hulls after the milling process, which results in a product that is free of viable weed and/or rice seed. Despite being an organic compound, rice hulls consist mainly of lignin, cutin and insoluble silica, providing a slow breakdown of particles and therefore making them an appropriate substrate for long-term crop production. Recent research conducted at the University of Arkansas indicates that amending pine bark with up to 40% PRH will not significantly decrease plant growth or increase the volume or frequency of irrigation for container-grown plants after one and two growing seasons. A number of researchers have demonstrated that PRH is a suitable alternative to perlite in greenhouse substrates. In bedding plant trials at the University of Arkansas, the highest shoot and root growth occurred for plants grown in substrates containing 20% to 30% PRH. The pH of composted rice and parboiled rice hulls ranges from 5.7 to 6.2, and 6.2 to 6.5, respectively. Fresh rice hulls are light in weight (bulk density 6 to 7 lbs/ft^3) and are useful to increase drainage and aeration. Fully composted rice hulls will hold more water than unprocessed hulls. Either fresh or composted rice hulls have a high Mn content. To avoid problems with Mn toxicity, maintain the media pH above 5.

Cotton Gin Trash

Cotton gin trash is another organic waste product readily available in Arkansas. **Composted** gin trash can increase the water- and nutrient-holding (CEC = 200 meq/100 gm) properties of media and has a pH of 5.5 to 6.0. High soluble salts can be a concern, but this can be reduced quickly through leaching with water. Several studies have shown reduced plant growth when the media contains > 50% gin trash.

Biochar

Biochar is a carbonaceous residue that has long been considered as a soil amendment for mineral soils but is more recently garnering attention as an amendment for soilless container substrates. It is produced by exposing a variety of organic matter sources to extremely high temperatures (800° to 1,500°F) in the absence of oxygen. The thermochemical process is called pyrolysis. The simple fact that the manufacturing process (i.e., temperature, feedstock material) varies so greatly means the output product is quite variable. The simplest analogy is compost. The chemical and physical properties of the finished product will vary depending on the feedstock (input) and the production conditions (e.g., temperature, duration of pyrolysis). Physical sizing can be controlled by post-production screening, but the chemical properties (e.g., nutrient concentrations) of biochar will vary depending on the organic feedstock. pH is most often alkaline in the range of 8 to 10.

Media Components – Inorganic Amendments

Perlite

Perlite is most commonly used as a component in greenhouse growing media or nursery **propagation** applications. It is produced by heating igneous rock under high temperatures (1,100° to 1,600°F). Perlite differs from vermiculite in that the finished product is a "closed cell" that does not absorb or hold water. For this reason, it is usually included in a mix to improve the drainage or increase the percent of aeration. Perlite is lightweight (6 to 8 lb/ft^3), chemically inert, pH neutral, sterile and odorless.

Vermiculite

In some ways vermiculite is similar to perlite in that they both originate as mined minerals that are then heated to produce a finished product. Perlite and vermiculite differ, however, in the rationale for including them in a mix. Perlite is usually included in a mix to increase drainage but does not increase the retention of nutrients. In contrast, vermiculite with its plate-like structure holds large quantities of water and positive-charged nutrients like potassium, magnesium and calcium.


Vermiculite


Perlite

Vermiculite is sterile and light in weight (5 to 8 lbs/ft^3). The pH of vermiculite will vary depending on where it is mined. Most U.S. sources are neutral to slightly alkaline, whereas vermiculite from Africa can be quite alkaline (pH = 9). Vermiculite is used extensively in the greenhouse industry as a component of mixes or in propagation. It is usually sold in four size grades: #1 is the coarsest and #4 the smallest. The finer grades are used extensively for seed germination or to topdress seed flats. Expanded vermiculite should not be pressed or compacted, especially when wet, as this will destroy the desirable physical properties.

Vermiculite has been the focus of news attention several times over the past 30 years with regard to the issue of potential contamination with asbestos-related fibers from a related mica mineral called tremolite. Because of this concern and attention, most mines monitor this issue closely to avoid problems with commercially available product. As is the case with dry peat moss, handlers should wear a dust mask to avoid inhaling these materials.

Sand

Sand is a common amendment used in propagation applications and is occasionally used in a greenhouse or nursery mix. Sand is typically selected as a media component to improve the drainage or to act as a ballast to decrease container blow-over in outdoor container nurseries.

While sand represents a wide range in particle sizes, growers generally use medium to coarse sands (0.25 to 2 mm). Preference should be given to deep-mined sharp sands which are mostly silicon dioxide. Avoid using calcareous sands or sands from the ocean that are obviously saline in nature. Sand rarely occupies more than 10% of the volume of a mix simply due to the tremendous weight (bulk density of 80 to 100 lbs/ft^3).

Soil

Soil is still occasionally used in a container mix primarily because it is locally available or to add weight to a predominantly organic-based mix. Some outdoor nurseries strip the topsoil in preparation for installing container beds, stockpile the soil and then use it over time as a minor component (e.g., 10%) in the mix. Major considerations when using would be the amount of weed seed and presence of residual chemicals. In general, soil should be a minor (<10%) component or not used at all in modern container mixes.

Rock Wool

Mineral or rock wool has been used extensively in Europe and is used in a limited way in the U.S. greenhouse market. Like perlite and vermiculite, it originates from a natural mineral (alumino silicates with some calcium and magnesium) that is heated to 2,700°F to form fibers that are used to make blocks or cubes as a finished product. Blocks or slabs of rock wool are used extensively by hydroponic growers of greenhouse vegetables. Rock wool typically has an alkaline pH, is sterile and chemically inert.

Other Inorganic Amendments

Other amendments that Arkansas growers might hear about but are generally not used extensively include pumice, calcined clay, diatomite and zeolites.

Typical Greenhouse Mixes

Common media components used in the greenhouse include peat, perlite, coir, parboiled rice hulls and fine bark. Compared to traditional container nurseries, most greenhouses will use sterilized media.

Premixed

Premixed media is a common sight in the greenhouse industry. Suppliers offer a diversity of mixes in either prepacked (bags, bales, super sacks) or bulk forms. Recipes are specially formulated for propagation, specific crops (e.g., Poinsettia mix) or general crops. If significant quantities are required, growers can purchase media customized to their specific operation by requesting specific amendments including lime, wetting agents and fertilizer. Primary components in a greenhouse mix are peat moss and perlite.

Mix Your Own

A number of recipes are available for greenhouse mixes and may reflect raw materials or trends for that part of the country. The following is one example.

Cornell Peat-lite Mix A

Component	Amount per yd^3
Peat moss	0.5 yd^3
Coarse vermiculite	0.5 yd^3
Triple superphosphate	0.5 lb
Dolomitic limestone	5 - 10 lb
Calcium or potassium nitrate	1 lb
Trace element package	manufacturer's recommended rate
Wetting agent	manufacturer's recommended rate

This mix would have a high water retention since it is simply based on peat and vermiculite components.

Typical Nursery Mixes

The most common components in an outdoor nursery mix include bark, peat, sand and soil. Softwood bark typically comprises from 80% to 100% of a mix. Peat is often included to increase the water-holding capacity of a mix, while sand and soil are often added to increase the weight, which reduces container tip-over. Many growers use a recipe of 80% pine bark, 10% peat and 10% sand.

General Mixing and Handling Recommendations

- Test the media pH, total soluble salts (electrical conductivity) and wettability before use.
- Do NOT make changes to your current growing media without experimenting first to see if changes may affect your cultural practices.
- Thoroughly mix components, but don't overmix, especially if a medium contains vermiculite or plastic-coated slow-release fertilizer.
- Do NOT store media that contains fertilizer for long periods of time, especially if the media is moist.
- Avoid contamination of components or finished media by keeping amendments in closed bags or by covering outdoor piles.
- Do not allow mixes containing a significant amount of peat moss to dry out.

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