

# Potting Mix Choices and Recommendations

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There are no "one size fits all" recipes for growing containerized ornamental plants. However, not all nursery crops thrive under the same cultural practices related to irrigation frequency, nutritional regimes or container potting mixes. The predominant potting components in nurseries in most of the eastern U.S. are pine bark, sand and sphagnum peat moss. Some alternative materials that are being used include shredded coconut husks (coir), composted yard wastes and animal wastes, composted cotton gin wastes, composted hardwood bark, mushroom compost, municipal compost, rice hulls, peanut hulls, and pecan shells. The stability and chemical and physical characteristics may limit the volume of alternative materials that can be used in a potting substrate. Unstabilized organic components decompose rapidly, leaving a full container, 3/4 full in a few weeks. Composted materials often lack the large coarse particles necessary for adequate aeration and cannot be used in volumes greater than 50% for most container substrates. Animal wastes characteristically have high electrical conductivity (soluble salts) and nutrient levels, therefore are usually limited to 10 to 30% volume in potting substrates. Potting mixes containing compost components will generally have higher pH levels ranging from 6.0 to 6.5 in contrast to pine bark or sphagnum peat moss substrates which even with dolomitic limestone addition frequently range 5.0 to 6.2. The higher pH is generally not a problem for growing most nursery crops but, since composts have a "liming effect" dolomitic limestone should not be added to compost containing potting mixes and usually, no minor element packages are required.

## Physical properties of substrates

Physical properties for container potting substrates include, particle size distribution, total porosity, air space, water holding capacity (container capacity), available water capacity and unavailable water content and bulk density. There are no distinct physical property standards for container substrates, however, normal ranges for nursery containers substrates after irrigation and drainage are easiest to manage within the normal ranges shown in Table 1. A balance between aeration and moisture content are necessary for optimum growing conditions. Fewer problems related to over-watering during production would be expected with potting mixes that have at least 15% air space. A perched or saturated water table is created by the bottom of the container. In a container, air space increases as height increases above the bottom of the container. Air space also increases as water is lost.

Addition of sand to pine bark tends to increase moisture retention and available water content but reduces air space and total porosity (Table 1). The greatest liability is that air space may be reduced too much, requiring careful irrigation management to avoid water-logging and anoxia of roots. Growers frequently add sand to pine bark for nursery substrates, but may think that the only reason is to increase the weight of the container, to reduce blowing over of containers in growing beds. Another less obvious reason to add fine particle components such as sand is that the infiltration rate of irrigation water is slowed down as it moves through the container profile. This promotes wetting of the substrate when compared to coarse pine bark particles and through which water can channel rapidly to the bottom of the container. However, too much sand can increase weight too much, creating handling and shipping difficulties.

When greatly different particle sizes of potting materials such as fresh pine bark and sand are combined, considerable component shrinkage occurs. In this case one cubic yard plus one cubic yard is not equal to two cubic yards. The shrinkage may yield a volume of 1.5 cubic feet. In this situation a great increase in bulk density which is the solid composition of the substrate would be expected. Particles less than 0.5 mm in pine bark create many of the pores that hold water. Fresh pine bark has very few particles less than 0.5 mm so growers add other components to replace the fines for better moisture retention (Tables 1 & 2). Moisture holding characteristics for organic components are different from soils, since water is held within particles and fibers as well as between particles as in soils. Moisture held within chambers in pine bark particles and inside fibers of sphagnum peat moss are available and explored by plant roots.

Irrigation and fertility must be closely managed to optimize air, water and nutrient characteristics of the substrate to avoid excessive leaching or salt build up or too wet or dry conditions in containers.

### **Particle size considerations for potting substrates**

The age and handling prior to use as a potting component affect the physical and chemical characteristics of pine bark. Loblolly pine is the predominant species of pine used for pine bark potting substrates over much of the Eastern U.S. This pine bark is generally considered to be non-phytotoxic and can be used without aging or composting. Aging produces a more stable material and allows break down of larger particles, degradation of wood, cambium and complex compounds associated with the turpentine like smell of fresh pine bark. Aged pine bark is sometimes referred to as composted bark, although in the strictest sense, unless pine bark is amended with a nitrogen source, moistened and turned regularly as described as composting procedures for leaf yard wastes and animal wastes, true composting may not fully occur. Stability of an organic material is frequently based upon its carbon to nitrogen ratio. For most organic potting components the ratio should be at least 30: 1 (C: N), however, even composted pine bark may not have this low of a C/N ratio since most of the pine bark is lignin and not cellulose.

Stability and particle sizes of potting components and how two or more components "fit" in the mix is important and creates the physical properties discussed in Table 1. Stable components are necessary since rapid decomposition will also continually change the physical properties, decreasing air space and increasing moisture retention. Nitrogen applied for plant growth may also be used during decomposition, resulting in reduced growth of container plants. Particle size distributions of potting substrates can be measured. Results generally compliment physical property data, but can be used to diagnosis potential aeration and water retention difficulties if used for crop production (Table 2).

Table 1. Physical properties of selected substrates.<sup>z</sup>

Substrate <sup>y</sup>	Total Porosity	Air Space	Container Capacity (% Volume)	Available Water	Unavailable Water	Bulk Density (g/cc)
Fresh Pine Bark	86	42	44	13	31	0.19
Aged Pine Bark	82	31	51	21	30	0.19
Fresh PB + Sand	81	31	50	19	31	0.34
Aged PB + Sand	82	27	55	24	31	0.36
Normal Ranges	50.0-	10.0-30.0	45.0-65.0 (% volume)	23.0-35.0	23.0-35.0	0.19-0.52.0 (g/cc)

<sup>z</sup>All analyses performed using standard soil sampling cylinders (7.6 cm ID, 7.6 cm h)  
Air Space and Container Capacity affected by height of container.

Table 2. Particle size distribution of selected nursery container substrates

Sieve No.	Opening (mm)	Substrate <sup>y</sup>			
		Fresh Pine Bark	Aged Pine Bark	Fresh PB + Sand	Aged PB + Sand
0.25	6.3	9.0	13.3	5.0	6.1
10	2.0	47.3	36.2	28.7	26.4
25	0.7	25.7	23.2	34.3	30.5
		82.0%	72.7%	68.0%	63.1%
35	0.50	6.8	7.3	14.3	14.5
60	0.25	7.6	10.0	14.3	14.5
140	0.11	2.8	7.2	2.8	5.7
pan	0.00	0.8	2.8	0.6	2.3
		18.0%	27.3%	32.0%	37.0%

<sup>z</sup>Substrates as in Table 1.

## Handling substrate inventories

Good sanitation practices for potting components at the nursery are extremely important. Storage, mixing and handling areas should be located at higher elevation than growing areas to avoid contamination from runoff from growing beds which could potentially inoculate all newly potted materials with disease problems in growing beds. Bulk potting materials such as pine bark and sand should be stored on concrete pads to prevent contamination by weed seeds and spores of pathogens associated with bare soil. Bagged materials such as sphagnum peat moss and bundles of new containers should be stacked on pallets above any standing water and covered to reduce ultraviolet breakdown of bags risking contamination. Fertilizer ingredients should be stored in dry covered storage areas to prevent premature dissolution or release causing elevated nutrient levels when used during mixing and potting plants. Recycled containers should be washed free of previous mineral or organic potting material and then sterilized with commercially available disinfectants or a 10% sodium hypochlorite solution. Care in storing and handling components, containers and all materials used in potting new crops is a critical pre-plant step in nursery crop production that can prevent weed, disease and other cultural problems from occurring later in production.

Handling procedures before bulk supplies are delivered to a nursery are also important. Poor inventorying practices of pine bark, hardwood bark, composts or other organic components can be detrimental for use as a potting substrate. Bulk inventory piles of these materials should be monitored and turned when temperatures exceed 150° F. The materials may also require re-moistened if dry areas in inventory piles are observed. If inventory piles of fine particle materials ( $\leq 5/8$  inch) are stacked at heights greater than 8-10 feet or equipment is driven onto inventory piles air exchange in the piles can be greatly reduced. Inventory piles can become very hot reaching temperatures of 180° F or higher and may spike to temperatures where combustion occurs in the inventory. Steam rising from hot inventory piles indicates loss of moisture and dry bands can be observed, usually 1.5 to 3 feet below the top of inventory piles that rewetting will require use of a wetting agent before the dry material can be used successfully in potting substrates. If bulk inventories are not monitored, anaerobic pockets may develop in the inventory piles, which characteristically have low pH, high soluble salts levels and phytotoxic effects on plants.

There are at least two methods of inventorying pine bark are used by bark suppliers. If inventories are handled as a coarse product prior to screening and separation of nuggets, mini-nuggets and mulch from the fine particles marketed as nursery potting bark, heating and anaerobic conditions in the inventories are usually not a concern. If nursery-potting bark is inventoried after separation of coarse particle materials, more handling and monitoring is required. In bulk nursery pine bark piles, dry bands may develop which contain less than 34 % moisture content by weight and can not be readily re-wet. Plants potted from these areas in an inventory pile may die due to inadequate moisture retention. Areas in inventory piles below dry bands may begin an anaerobic decomposition. If electrical conductivity (soluble salts) is checked using a 2:1 water to bark extraction procedure, EC's as high as of 2.5 millimhos/cm and pH values below 3.5 have been reported. These conditions can cause plant death especially for liners potted from these areas of pine bark inventories. Liners suffer from the excess soluble salts and from the low pH. Other compounds extracted from the pine bark under anaerobic conditions may also be phytotoxic to plant roots.

Pine bark in dry ( $\leq 50\%$  moisture by weight) inventories may also develop high fungal populations recognized by clouds of spores when disturbed. If these inventories are used for potting, rapid growth of mycelium may occur which make irrigation of plants in containers very difficult and may result in crop losses. Newly potted liners dry out simply because the hyphae mass in the bark, sheds water and no water is retained by the potting substrate. Liners die of desiccation. Plants shifted up to larger containers, do not grow into the affected pine bark outside of the existing root ball for several months. To prevent this problem, processed bark fine particle nursery-potting bark (usually 5/8 to 3/8 inch and finer particles) should be wet to 50% before being placed in inventory piles. Inventory piles should be turned and re-moistened occasionally if bark is aged.

To avoid problems related to inventorying procedures of pine bark sources, nurserymen should watch or designate someone to observe as bulk potting materials are unloaded at the nursery. If inventories are excessively hot and steamy or clouds of spores are observed, check pH and electrical conductivity. If clouds of spores are noticeable, thoroughly soak the entire inventory. Consider not using the inventory immediately if any of these concerns appear after observation and testing. Inventories can usually be wet thoroughly and left 1 to 2 weeks, then re-checked for to determine usability. If bulk inventories are not used within a few weeks and are left undisturbed for periods over one month at the nursery, check for moisture content, heat, spores, pH and electrical conductivity before potting new crops. If observations and results cause questions about usability, irrigate and turn the inventory and check it after two weeks.