NICK HAND: The stock that is ready for sale is what we are using for cuttings.

DICK AMMON: Question for Nick Hand. I would like for you to tell me something about grafting lilac onto green ash.

NICK HAND: It is easy. We changed from privet to green ash, *Fraxinus pennsylvanica*, to avoid suckering. Ash seem to act as a nurse graft. We bench graft in February.

LYNN TABER: Question for Dick Ammon. How are the maples handled after the graft is made? Are they put into a structure, or is material packed around them? What is the procedure after the grafting takes place?

DICK AMMON: From what I have seen most of them are put into a poly tent until they harden and there is some callus. This is the way we do it. We make sure there is a good callus before we take the plastic off.

WAYNE SAWYER: Question for Carl Bauer. Have you experimented with ground heat? You said rooting did not occur until soil temperature reached 70 degrees. If you kept the soil at 70 degrees all the time, could you cut down this production period of 2 years?

CARL BAUER: You probably could, but I don't think you could justify production costs. Without heat, the cuttings usually root uniformly. By waiting until the soil warms naturally, we obtain a uniform crop. I think heating would accelerate the growth, but the cost would not be justified.

MIKE HALLUM: Question for Carl Bauer: I would like to ask if you use any fungicides in preparation of cuttings.

CARL BAUER: I think it would probably be a good practice to use a solution of captan prior to sticking. We have done this. We are not sure whether or not it is absolutely necessary. This is the only preparation we use.

## PINE BARK IN POTTING MIXES, GRADES AND AGE, DISEASE AND FERTILITY PROBLEMS

RAYMOND L. SELF

*Ornamental Horticulture Field Station*
*Auburn University Agricultural Experiment Station*
*Mobile, Alabama 36608*

Pine bark (phloem and cork cells) is produced by vascular cambium and cork cambium. Vascular cambium is the 2 to 4 cell layer which separates the phloem from the wood (xylem). The living part of the phloem consists primarily of food transporting cells called sieve tubes, which live one to two years before dying and becoming the outer bark. Cork cambium is the outer portion of the living phloem and produces the protective layer of cork cells. The inner bark, or living phloem, is often erroneously referred to as the cambium.

The literature on pine bark usages and problems is becoming voluminous but with several years of usage in many geographic areas, a clearer picture is now arising as to desirable grades, effect of aging, effect of composting and problems of disease and fertility.

**Grades.** Grades refers to particle size and composition. Both particle size and composition from a single species of tree will be influenced by season of harvest, the equipment used to remove the bark from the log or pole, and screen size of the hammerhill. Knives (Rosier head), Cambio debarkers, and rollers are the most common debarking equipment in use. The Rosier head consists of a series of knives on a head that rotates around the log, removing all of the bark and some of the wood, producing a straight pole or log. The Cambio debarker also consists of a revolving head with several projections, which are spring loaded so as to exert only enough pressure to remove the bark and cambium but not the wood. The log goes through the head, which turns at 200-300 R.P.M. Other equipment consists of a series of rollers over which the log is passed as the log rotates. Sometimes the logs are first passed over the rollers to remove the bark, then through the Rosier head. A drum type debarker is also used by Hiwasse Land Company, Guntersville, Alabama. This consists of a large revolving drum with screen.

The tumbling action of the logs removes the bark, which falls through the large screen. This bark is passed over a 3-inch screen, then a second screen which catches the ¾ to 2-inch chunks, then over a third screen which retains the ⅜ to ¾-inch chunks and allows the fines to fall through. The large chunks retained by the first screen are passed through a chipper and then over the other screens again. The final products consist of decorative bark chunks, ¾ to 2-inch mulch, ⅜ to ¾-inch flakes (used in potting soil), and fines. The barks for potting soils are aged 4 to 6 months to decompose some of the phloem, to improve wettability, and to produce a darker color.

The bark removed by the cambio debarker of Crosby Lumber, Bay Minette, Alabama, is very desirable for the nursery trade. The usual screen size used on the hammermill is one inch, which produces particles varying from dust to chunks or slivers ranging from 1½ inches in length up to slightly less than 1 inch in width. Seventy to 80 per cent of the particles range from ⅛ to 1/42 with the remainder consisting of larger particle sizes. This is an excellent range for a growing medium. (Smaller screens, ½ to ¾ inch, and not in use at this mill, produce finer particle sizes that are more desirable for propagation.)

Pine bark from trees harvested in the fall or winter, when the sap is down, will have more dust and smaller particles than that harvested in spring or summer when the sap is "rising". Various impurities often present in bark include living phloem, wood, sand, and soil adhering to the logs and metal from the debarker or hammermill.

Excessive amounts of dust and fine particle sizes are undesirable as they result in waterlogging of the mixture. These sizes are converted to humus during composting. Coarse bark:sand mixtures are hard to wet at first and initially do not retain sufficient moisture for early plant growth without frequent watering. Wettability improves as the coarse particles disintegrate or after addition of a wetting agent.

**Aging.** Aging is unnecessary except to stockpile the bark for future use and improve wettability. During aging, the stockpile goes through a heat, resulting in darkened color. Some phloem and bark is partially decomposed and may develop a burned appearance. This decomposition, which occurs in big piles with inadequate aeration, is undesirable.

Aging without nitrogen addition does not result in composted bark, because the temperature of the pile does not get high enough to kill the pathogenic organisms.

**Composting.** Composting of pine bark is the reduction of the cellulose part of the fine bark particles and bark fiber into humus through reduction of the carbon:nitrogen ratios by the action of bacteria and fungi when nitrogen is added. The remaining larger, various particle sizes break down slowly over several years.

Hoitink and Poole of Ohio State (1) report that composting of pine bark can be accomplished in 8-feet high by 15-feet wide stacks in 6 weeks by turning the pile every two weeks, after one pound of actual nitrogen has been added per cubic yard. Hardwood requires 2 to 3 pounds of nitrogen per cubic yard and 10 weeks to compost.

Benefits of composting include the destruction of pathogenic organisms and the reduction of the carbon:nitrogen ratio so that plants need not compete for nitrogen (2). This advantage is largely eliminated by the use of slow-release forms of nitrogen and the elimination of wood cellulose, phloem, and dust bark particles.

Fresh pine bark contains compounds harmful to some seedlings and young rooted cuttings. Aging or composting destroys these compounds. Hoitink and Poole (1) have determined that fresh pine contains compounds that retard development of root pathogens such as *Rhizoctonia*, *Phytophthora*, and *Pythium*. They state that these compounds are destroyed by composting.

Experimental work has been conducted at the Ornamental Horticulture Field Station, Auburn University, to determine the necessity of composting pine barks. (3)

It was determined that fresh bark could be used very successfully to produce 6-inch container-grown plants. Very little difference in growth rates were observed with 0, 30, 60, and 90 days composting. Ammonium nitrate as the source of nitrogen reduced growth rates of all plants tested as compared to Nitroform and Osmocote sources of nitrogen. Salts built up to a toxic level between 30 and 60 days of composting, but were readily removed by leaching. Enough fertilizer remained to carry the plants to maturity without further fertilization of the best treatments.

Interviews with nurserymen regarding mixes from the two common sources of bark in the Mobile area reveal divergent opinions. However, these can be explained by the differences in their methods of using the bark. The Crosby bark mentioned earlier is produced by the revolving Cambio head and is hammermilled through a 1-inch screen. The resulting product consists of a range of particle sizes from 1½ inches to dust.

It is highly satisfactory for production of plants in 6-inch or larger containers, but some nurserymen find it too coarse for propagation. We have screened this bark through a ½-inch screen and produced a medium very suitable for rooting of cuttings. We have further enhanced its value as a rooting medium by incorporating 2½ lbs of Osmocote 18-6-12 or 19-6-12 per cubic yard.

One year we mixed this bark with Birmingham shale at a 4:1 ratio with excellent results when the bark was not aged or composted. However, the mix would have been improved by the addition of more fines, peatmoss, or the removal of the coarse particles by passing over a ½-inch screen.

Another grade of bark commonly used in the Mobile area is referred to as Stemo bark. This bark is available in 2 or 3 sizes, ranging downward from ½ inch. It has been aged several months and has a dark brown to black color.

With mixes of hardwood bark and pine bark often produced by some mills, composting is necessary to eliminate problems of high pH, excess manganese and tannic acids or other unknowns. Certain facts are generally known from research reported by Gartner of the University of Illinois and by Hoitink of the Ohio State University. These facts are as follows:

1. Hardwood bark pH reaches a high of 8.0 plus in composting, and requires one pound of elemental sulphur per cubic yard to reduce the pH to 6.5 plus.

2. Manganese level of hardwoods is excessive but can be balanced by the addition of one pound of ferrous sulfate or chelated iron per cubic yard.

3. Tannic acid or phenoic acid level is excessive but can be reduced by composting. Gartner reports tannic acid content is very high. Composting procedures recommended are 5 lbs. of superphosphate and 6 lbs. of ammonium nitrate per cubic yard.

The above recommendations apply to the composting of hardwood barks, which requires a minimum of 60 days, along with several complete mixings and turnings of the piles.

The above facts confuse the picture if one thinks he is working with pine bark when the material is really a mixture of pine and hardwoods.

A recent sample of composted material toxic to young seedlings was submitted to the Station for examination. Both the pH and calcium as well as phosphorus and potash levels were very high. The material appeared to be aged, partially decomposed bark, but was really aged mahogany chips and sawdust.

**Fertilization Problems.** The use of pine bark in the potting mixture poses no serious problem if the pH is adjusted upward and slow-release forms of nitrogen are used. The pH of raw pine bark is 4.1 to 4.2, and increases slowly during composting to a high of 4.5 or higher. It is postulated that the increase in pH is due to the release of calcium, magnesium, and potassium which are present. Pine bark contains approximately 1.0 percent minerals whereas pine wood is reported to contain approximately 0.3 percent minerals.

Research at this Station has indicated that if the potting mixture contains 50 percent or more of pine bark, 15 pounds of dolomite lime per cubic yard will be needed to maintain a pH of 6.0. We are producing excellent plants in 100 percent fresh pine bark or 3:1:1 (bark:peat:Birmingham shale) amended with a complete fertilization program.

The pre-plant mixture for the above two media consists of the following poundages per cubic yard: 15 dolomite; 2 superphosphate; 2 gypsum; ¼ Nu-iron; micronutrients FTE 504, or 008 at ¼, FTE 555 at 1, or 2 Esmigran at 4; ⅛ FTE 187; 2 FTE 519 potash; 3.5 Nitroform; and 10 Osmocote 18-5-11. This mixture can be supplemented by liquid feeding or dry topdressing with complete slow-release fertilizers.

**Disease Problems.** Pine bark removed from trees infected with *Phytophthora cinnamomi*, the causal agent of the littleleaf disease, may pose a serious problem. Occasionally the *Phytophthora* has been identified in mixes containing pine bark, presumably removed from infected trees which are very often sawmilled.

Another fungus disease occurring very often in pine bark mixes several months after potting has been *Rhizoctonia* root rot. The association of this fungus with older bark supports the observations of Hoitink regarding the disappearance of the protective chemicals as the bark ages.

We have demonstrated a definite improvement in survival and growth of cuttings rooted in a bark mixture containing four ounces of Banrot 40 WP per cubic yard.

Another problem with bark is waterlogging, which leads to root rot caused by lack of air. This occurs when excessive fines are used, or when shavings, wood chips, or slivers incorporated with the bark have decomposed with a reduction in air space.

## LITERATURE CITED

1. Hoitink, H. A. J. and H. A. Poole. 1976. Composted bark mediums for control of soil-borne plant pathogens. *American Nurseryman* 144 (5):15,88.
2. Gartner, J. B., T. D. Hughs, and J. E. Klett. 1972. Using hardwood bark in container growing mediums. *American Nurseryman* 135(12):10-11, 77-78.
3. Self, R. L. and Oliver Washington. 1977. Effect of composting and slow release fertilizer program on pH and soluble salts changes over a 90 day period in soil piles. *Proc. SNA Res. Conf.* 22:15-17.

# COMPOSTING AND USE OF HARDWOOD BARK MEDIA FOR CONTAINER GROWING

GREGORY L. AMMON

*Ammon Wholesale Nursery*
*Burlington, Kentucky 41005*

In our container growing operation we have tried various soilless media. Since cost was the biggest factor to be considered, we had to search for the most available raw material that could be used. We have no source of peat moss or softwood bark within 400 miles. Hardwood bark is available about 100 miles distant. Information based on research work done by Dr. Jack Gartner at the University of Illinois led us to decide this would be our most practical medium. Due to the tannic acid content and heat build up, raw bark must go through a composting period before it can be used as a growing medium. We purchase raw hardwood bark from the Mead Paper Company in