HRI's Mission:

To direct, fund, promote and communicate horticultural research, which increases the quality and value of ornamental plants, improves the productivity and profitability of the nursery and landscape industry, and protects and enhances the environment.

wounding in combination with auxin may further stimulate rooting, the additional benefits to be gained from wounding are questionable and could be eliminated, thus reducing labor costs during preparation of cuttings.

Significance to the Nursery Industry

The results of this study indicate that light or heavy wounding in combination with IBA treatment need not be applied to Fraser's photinia stem cuttings to achieve satisfactory rooting. Adequate rooting can be attained simply by treatment with a concentrated IBA solution within a range of 5000 to 10,000 ppm. Elimination of wounding during preparation of cuttings will reduce labor costs.

Literature Cited

1. Bonaminio, V.P. and F.A. Blazich. 1983. Response of Fraser's photinia stem cuttings to selected rooting compounds. J. Environ. Hort. 1:9-11.

Soilless Mixes for Nursery Production

Dr. Roy W. Judd, Jr.*
Director, Technical Services
Premier Brands, Inc.
New Rochelle, NY 10801

I've had the opportunity to travel quite extensively up and down the East coast and into the Mid-West to visit nurserymen and had an opportunity to look at some of the soilless mixes that they are using for their production. Many have developed their mixes on a "by guess and by golly" approach, while others have proceeded to take a more scientific approach. The one mix that we find most often is the UC mix or 50% peat and 50% sand. That one seems to have stood the test of time and is used by many growers throughout the East coast. Other more adventuresome souls have experimented with such additives as perlite, vermiculite, hardwood and softwood bark, sewage sludge, styrofoam, sawdust, corn stalks, ground up rubber tires and other materials. It seems as if a company has a product that is of no value to anyone in the U.S. they always try to sell it to a nurseryman. This becomes very irritating, I would think, to you folks and to me personally because when I was with Extension work we were constantly questioned and queried and would we try this and would we try that. It just gets to be a hassle.

The first thing I'd like to look at is, "What do we really expect a mix to do? What do you as a nurseryman want the mix to do?" Well, first of all, the mix has to provide an anchor for the plant. It has to keep the plants in an upright position, hopefully hold them in place during strong winds, rains and other adverse weather conditions you might have. We want to provide an ideal environment for the roots, for the oxygen and the carbon dioxide exchange. And finally, we want it to last for long periods of time—up to 2-3-4 years, depending upon how quickly you can sell the crop.

Now, what do we look for in a mix? First of all, it has to be free from insects, diseases and weeds. It should also be free from harmful chemicals, such as herbicides, industrial pollutants, and other things. I have had the misforture of being called in three different times this year on chemical problems with container-grown nursery crops. They all involved herbicides of one type of another, mostly soil sterilants that had gotten into the mix either through the injector system, through run off into the irrigating ponds or, in one particular instance, it seemed to be that the nurseryman had a "friend" that didn't like him and put a few herbicides in his mix. And that happens, it really does, unfortunately.

What other things do we look for in a mix? We need good drainage and aeration. The roots cannot absorb water or nutrients except in the presence of oxygen. As the roots grow, they give off carbon dioxide which if it's not allowed to be taken from the mix, can become toxic to the roots themselves. The mix must drain well, but it should not shrink away from the side of the pot; so that when you irrigate, the water simply runs down the edge of the pot and out the bottom and does not wet the root system thoroughly. The soil mix should have about 30% air space in order to develop a root system such as you see here. It must be able to hold fertilizer, for short periods of time anyway, while the plants grow and develop.

The nutrient capacity of mixes varies quite extensively depending upon the material that is put into the mix. However, this is an area that is being worked on more and more by university people and we're finding that we actually know very little about the nutrient requirements for many of these plants. Soil tests are being developed to test for specific elements: nitrogen, phosphorus and potash. But we're finding that nitrogen, especially in the nitrate form, if it's not taken up fairly quickly by the plants, simply passes through the media and out the bottom of the pot. If bark is incorporated in the mix, we're finding that the ammonium is tied up very rapidly by the bark particles. And phosphorus, if you were growing in a soil mix, would become tied up in a soil, but in a

*Presented at the HRI New Horizons program during the 108th Annual Convention of the American Association of Nurserymen, July 19, 1983, Montreal, Canada. Not reviewed.

J. Environ. Hort. 1(4):106-109. December 1983

soilless media, phosphorus is also leached out through the bottom of the pot during watering. In many instances, by the end of the summer, the plants, if not given constant liquid feed, are starving. So you have to consider all the components that go into a mix before you can develop a good fertilizer program. The mix should be lightweight, especially if you're going to ship any distance; it must be uniform; and you should be able to reproduce it from one batch to the next.

Finally, you should know your production costs. The cost of the mix should be economically feasible to you. It should be the best mix that you can afford to grow your plants in. In talking with growers during my travels, when asked what their costs per cubic yard of mix might be, they answered, "well, it's between $20 and $30"—It could be closer to 30 or it could be closer to 20—they don't actually know! With a computer system such as the one Jim Jones talked about, it would be very easy to code your mixing costs as far as components, time, labor, and depreciation. And when someone says how much does it cost to make a yard of mix, all you'd have to do is push a button and it would be there on the screen in front of you.

Once you have the mix put together to your satisfaction, there are other tests that you should check. The pH should be tested to make sure it's at the right level you want to grow your particular plants. Soluble salt levels need to be checked to make sure that the fertilizer content is not too high or would not be detrimental to the plants going into it; test the N, P and K ratio; and finally test your water holding capacity. (**Publ. note:** Dr. Kenneth C. Sanderson of the Auburn University Department of Horticulture recently published an article, "Growing with artificial media: The advantages, disadvantages," in *Southern Florist & Nurseryman,* July 29, 1983, in which he includes a table giving the nutrient content, pH, and soluble salt levels of 23 pre-mixed growing media.) You should have about 25%-30% air space in order to grow a good plant.

I want to just mention one thing briefly: Along with the soil test of your media, you should have a pH test taken of your water supply. I have found that the pH of the water in many areas is 7.5 to 8.5. As a result, the pH in the media rises even though you're using an acid soluble fertilizer. If you're growing plants that want a low pH, then you could be in a lot of trouble. I have seen this in numerous instances and it should be checked. Not just tested by a state lab to say what the pH is and if it's safe to drink, but you should have a complete analysis done; this is with boron, zinc, iron, the whole works. It may cost a few dollars, but I think it will be well worth it in the long run.

Now let's look at some of the components that go into a mix. Probably the most universal is peat moss. That seems to be the starting point in about 90% of the mixes for the nursery container business. But it's interesting, when I started with the Extension Service about 25 years ago, peat moss was peat moss, and that's all. You would take a 6 cubic foot bag of peat moss and put it in the mixer with whatever else you had and out came the mix. But not all peat moss is created equal. For example, we're finding now that many of the nurserymen are requiring what we consider a more fibrous type peat. It has excellent aeration, excellent drainage, good water holding capacity, and good fertilizer holding capacity when compared with your darker, more decomposed peat or peat humus.

As I mentioned earlier, it seems as though if someone has something they don't know what to do with, they try to sell it to a nurseryman. This is the same with peat. In many states in the U.S., someone always stumbles onto a "peat bog" and then they start harvesting it and want to sell it to growers. It is like the peat that you see here on the right (slide) which is peat humus. It's heavy and does not drain well. If you use this type of material, you could have all kinds of problems.

The second basic material in most mixes is sand. You may say, well sand is sand. True, it is, but it should be sharp washed sand in this particular instance. We once had a problem with rooting Taxus cuttings which usually root very readily. We finally determined that the sand had too many fines, too many clay particles in it and was not allowing the water to drain. The sand was just plugging up and the water would practically sit on top of it. Sand is used in the mix for weight and drainage mostly. Perlite was used for awhile, but now it has become fairly expensive. It's very similar to sand. It does not hold moisture or fertilizer, but simply aids in drainage.

Vermiculite is another material that's used by many growers. It's used to increase the water holding capacity of the mix and also the fertilizer material. The problem with vermiculite, if you plan to have the container for more than two to three years, is that it has a tendency to flatten out.

Bark has created a lot of interest in the past few years especially when the price of peat moss went up during the short harvest year. However, now that the price of peat is down, possibly many people will get away from bark. Hardwood bark can cause problems if not composted properly. It can be composted in a minimum of 60 days with the addition of fertilizers. Many growers compost it themselves for about 6 months.

The advantages of hardwood bark are many. First of all it supresses many of the disease organisms that you find in the soil—Phytophthora, Pythium, Fusarium and others. It's light in weight, provides good air spaces, it may hold 10 to 15 times its weight in water, and also has good fertilizer capacity. Until recently it has been fairly inexpensive, but we're finding companies, especially paper mills, that are buying their bark now in order to get away from fossil fuels. Thus, in some areas it may be a little more costly.

The disadvantages of hardwood bark are many: It does have to be composted; it can cause a nitrogen deficiency—you may have to add more nitrogen as the plants grow because the bark, as it decomposes, ties up excess nitrogen; the pH rises in hardwood bark mix so when you make your mix, some form of sulfur should be added in order to hold the pH at a desired level.

Softwood bark can hold up to 20 times its weight in water and it should be composted, but it's not essential if it's chopped up fine enough. When composted a very short period of time, spreading it out and letting it dry—it makes an excellent addition to a soilless mix. Unfortunately, it does not suppress disease organisms as does the hardwood bark. It may take a little bit longer to wet, but the use of a wetting agent will overcome that particular problem.

Pine bark, or other softwood barks, do not break down very easily or very readily so when you use these materials, you should also add trace elements to your media. Pine bark or softwood barks have a tendency to dry out faster than hardwood bark. Therefore you need to apply more water and consequently perhaps a little more fertilizer.

Premier Brands has just finished a two-year study (in cooperation with the University of Connecticut) using a composted softwood bark. The results will be published in detail in *American Nurseryman* and also in *Nursery Business*. We found that a combination of 60% peat moss and 40% composted bark produced what we considered to be excellent plants. **(Publ. note:** Also of possible interest is Research Report 402—*Horticultural Uses of Bark Softwood and Hardwood: A Bibliography* by Franklin A. Pokorny, associate professor, Department of Horticulture at the College Station in Athens. (91 pages, no charge). This bibliography is a compilation of research information pertaining to the horticultural uses for bark prior to 1978. Assemblage of the early information regarding the horticultural usage of bark should be a valuable resource to researchers, industry and others with an interest in the utilization of bark in plant culture. Single copies available by writing to: Research Publications, Room 125 Barrow Hall, University of Georgia, Athens, Georgia 30602 or Dr. F.A. Pokorny, Department of Horticulture, University of Georgia, Athens, GA 30602.)

The other item that is making a lot of headlines these days with the nursery industry is composted sewage sludge. Actually, this is not new. You're all familiar with the Milorganite that has been around for 25 or 30 years. But now other large cities have decided that they want to market their materials. Consequently, the nurserymen and the greenhouse operators are the places where everybody starts. Philadelphia is presently selling composted sewage sludge—and a large composting plant is being developed on the West Coast. I believe it's in Oregon. It's an interesting material, but the problem is that in many instances it has industrial pollutants in it that you should be aware of. It also is very high in metal such as Zinc, Cadmium and Iron. If you want to try sewage sludge, I would suggest that you get a complete analysis of the material beforehand so that you know what is in it. It also has a tendency to be a little bit high in soluble salts. Most of the research that has been done indicates that no more than 30% of the mix should contain sludge.

Now what other additives should go into your soilless media or soilless mix? Depending upon your type of production practices—lime, superphosphate—a little bit, trace elements are essential and a small amount of fertilizer just to get the plants started. Then follow up your fertilizer program with a slow release material. I think this is a subject that you should have expanded upon at your next session. As I mentioned previously, this is a very interesting and exciting area and a lot of research work is being done at the present time. Also add a wetting agent because these materials are difficult to wet. Aqua Gro is just one of many products that could be used—either incorporated in the mix, or water after the mix is made.

A few comments about mixing per se—if you use a large rotating mixer, be sure to allow the media to mix only a very short period of time, perhaps two to three minutes. Once you go beyond the 3 minute time period in a large cement mixer, if you have used sand and peat, or sand and other materials, you'll find that the mix begins to break down because of the crushing and/or the abrasive action of both the mixer and of the materials. An Auger type mixer also has a tendency to crush the fibers of the peat and break up the perlite and/or the vermiculite. If you use this type of mixer, put your material through only once.

No matter what you're mixing, the area should be kept clean. Keep this operation away from weeds, insects, diseases and other harmful materials that might contaminate the mix.

To conclude, I have just a few other comments—and that's to give you some combinations of what some other growers are using: 1) 50% sand, 50% peat; 2) 40% peat, 40% vermiculite and 20% sand; 3) peat and bark —a couple of formulations—60% peat, 40% bark and 20% peat, 80% bark; 4) 40% peat, 20% sludge and 40% pine bark; 5) 40% peat, 40% pine bark and 20% sand. Now if you presently have a soil mix that's doing a good job for you and you're happy with it, I certainly wouldn't change, but I would suggest that perhaps you might want to look at some of these other materials or some other combinations of these materials. You can always try to improve on what you have.

(Publ. note: The following summary of selected premixed growing media may also prove helpful in your use and/or selection of soilless mixes for nursery production. It was prepared by J.W. Boodley when he was still with Cornell University, Ithaca, NY.)

ASB MIX—Sphagnum peat moss, nutrient charge (macro- & micro-nutrients). Size: 3 & 4 cu. ft.

BALL GERMINATING MIX — Composted fine pine bark, horticultural grade vermiculite, sphagnum peat moss, liquid nutrient starter solution (macro- & micro-nutrients), dolomitic limestone, & a wetting agent. Size: 45 lb (wt/cu. ft = 15 lb)

BALL GROWING MIX I — Composted pine bark, horticultural grade vermiculite, perlite, liquid nutrient starter solution (macro- & micro-nutrients), dolomitic limestone, & a wetting agent. Size: 45 lb. (wt/cu. ft = 17 lb)

BALL GROWING MIX II — Composted pine bark, horticultural grade vermiculite, sphagnum peat moss, perlite, liquid nutrient starter solution (macro- & micro-nutrients), dolomitic limestone, & a wetting agent. Size: 45 lb (wt/cu. ft = 17 lb)

FAFARD PEAT-LITE MIX — Sphagnum peat moss, horticultural grade vermiculite, essential starter nutrients (macro- & micro-nutrients), & a wetting agent. Size: 4 cu. ft (wt/cu. ft. = 8-10 lb)

FAFARD MIX, No. 2-G—Sphagnum peat moss, horticultural grade vermiculite, perlite, granite sand, essential starter nutrients (macro- & micro-nutrients), & a wetting agent. Size: 3 cu. ft. (wt/cu. ft = 13-15 lb)

FAFARD MIX, No. 3 — Sphagnum peat moss, horticultural grade vermiculite, perlite, granite sand, screened composted pine bark, essential starter nutrients (macro- & micro-nutrients), & a wetting agent. Size: 3 cu. ft. (wt/cu. ft = 14-17 lb)

FAFARD MIX, No. 4 — Sphagnum peat moss, horticultural grade vermiculite, screened composted pine bark, essential starter nutrients (macro- & micro-nutrients), & a wetting agent. Size: 3 cu. ft. (wt/cu. ft = 16-19 lb)

FISONS-WESTERN PEAT CORP., SUNSHINE MIX No. 1 — Sphagnum peat moss, horticultural grade vermiculite, liquid starter solution (macro- & micro-nutrients), & a wetting agent. Size: 4 cu. ft. compressed.

FISONS-WESTERN CORP. SUNSHINE MIX No. 2 — Sphagnum peat moss, horticultural grade vermiculite (no added nutrients). Size: 4 cu. ft. compressed.

HECO SOIL REPLACER #1 — Sphagnum peat moss, perlite (macro- & micro-nutrients, good for 3 weeks' growth).

HECO SOIL REPLACER #2 — Sphagnum peat moss (macro- & micro-nutrients, good for 4 to 8 weeks' growth).

JIFFY MIX — Sphagnum peat moss, horticultural grade #3 vermiculite, nutrient starter charge (macro- & micro-nutrients) & a wetting agent. Size: 25 lb. (wt/cu. ft = 7-8 lb)

JIFFY MIX PLUS — Sphagnum peat moss, horticultural grade #3 vermiculite, nutrient starter charge (macro- & micro-nutrients), wetting agent. MagAmp 7-40 @ 10 lb/cu. yd. Size: 25 lb. (wt/cu. ft. = 7-8 lb)

JUNIUS PEAT-LIGHT MIX — Combination of sphagnum, sedge & reed peat, horticultural grade #3 vermiculite, perlite, nutrient charge (macro- & micro-nutrients), & a wetting agent. Size: 3 cu. ft. bulk.

NATURE-LIF POTTING SOIL (H.F. Michell Co.) — Peat moss, perlite, composted cow manure, earthworm castings. Nutrients are derived from components of mix (macro- & micro-nutrients). Size: 3 cu. ft. (wt/cu. ft = 21 lb)

PREMIER BRANDS PRO-MIX, PEAT-LITE MIX — Sphagnum peat moss, horticultural grade vermiculite, nutrient charge (macro- & micro-nutrients), & a wetting agent. Size: 3 or 4 cu. ft.

PREMIER BRANDS PRO-MIX A — Sphagnum peat moss, horticultural grade vermiculite, nutrient charge (macro- & micro-nutrients), & a wetting agent. Size: 5.5 cu. ft. compressed bale.

PREMIER BRANDS PRO-MIX BX — Sphagnum peat moss, horticultural grade vermiculite, perlite, nutrient charge (macro- & micro-nutrients), & a wetting agent. Size: 5.5 cu. ft. compressed bale.

PREMIER BRANDS PRO-MIX C — Sphagnum peat moss, horticultural grade vermiculite, perlite, dolomitic limestone, superphosphate (no N or K), micro-nutrients, & a wetting agent. Size 5.5 cu. ft. compressed bale.

SOUTHLAND MIX S1-3 — Sphagnum peat moss, composted pine bark, composted hardwood bark, horticultural grade vermiculite, perlite, dolomitic limestone, 10-10-10 starter fertilizer with trace elements, basic slag (phos), & a wetting agent. Size: 3 cu. ft. (wt/cu. ft. = 16-18 lb.)

STERLING PEAT — 100% sedge peat.

VAUGHAN-JACKLIN MIX #1 — Composted pine bark, horticultural grade vermiculite, perlite, liquid nutrient starter solution (macro- & micro-nutrients), calcium carbonate limestone, & a wetting agent. Size: 3 cu. ft. (wt/cu. ft. = 18 lb)

VAUGHAN-JACKLIN MIX #2 — Sphagnum peat moss, horticultural grade vermiculite, perlite, liquid nutrient starter solution (macro- & micro-nutrients), calcium carbonate limestone, & a wetting agent. Size: 4 cu. ft. (wt/cu. ft. = 7½-8 lb)

VSP MIX (Michigan Peat Co.) — Sphagnum peat moss, horticultural grade #3 vermiculite, nutrient starter charge (macro- & micro-nutrients), & a wetting agent. Size: 6 cu. ft. bale.

VSP II — Michigan sphagnum peat, horticultural grade #3 vermiculite, nutrient starter charge (macro- & micro-nutrients). Size: 2 cu. ft. bag (wt/cu. ft. = 22 lb)

REDI-EARTH (W.R. Grace Co.) — Sphagnum peat moss, horticultural grade #3 vermiculite, nutrient charge (macro- & micro-nutrients), & wetting agent. Size: 4 cu. ft. (wt/cu. ft. = 7.9 lb)

METRO-MIX 200 (W.R. Grace Co.) — Sphagnum peat moss, horticultural grade #3 vermiculite, perlite, granite sand, nutrient charge (macro- & micro-nutrients), & a wetting agent. Size: 3 cu. ft. (wt/cu. ft. = 13-15 lb)

METRO-MIX 220 (W.R. Grace Co.) — Sphagnum peat moss, horticultural grade #3 vermiculite, perlite, nutrient charge (macro- & micro-nutrients), & a wetting agent. Size: 3 cu. ft. (wt/cu. ft. = 7-9 lb)

METRO-MIX 300 (W.R. Grace Co.) — Sphagnum peat moss, horticultural grade #3 vermiculite, perlite, granite sand, composted pine bark, nutrient charge (macro- & micro-nutrients), & a wetting agent. Size: 3 cu. ft. (wt/cu. ft = 13-15 lb)

METRO-MIX 350 (W.R. Grace Co.) — Sphagnum peat moss, horticultural grade #3 vermiculite, granite sand, processed bark (patented), nutrient charge (macro- & micro-nutrients), & a wetting agent. Size: 3 cu. ft. (wt/cu. ft. = 13-16 lb)

METRO-MIX 500 (W.R. Grace Co.) — Sphagnum peat moss, horticultural grade #3 vermiculite, granite sand, processed bark (patented), composted pine bark, nutrient charge (macro- & micro-nutrients), & a wetting agent. Size: 3 cu. ft. (wt/cu. ft. = 16-18 lb)