Final Report to
The Agricultural Research Foundation
and the
Nursery Regulatory Committee

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Project Title: Chemical characterization of Douglas fir bark used for container production

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There were two objectives to this research: 1) document baseline chemical properties of Douglas fir bark that have relevance to container producers and 2) compare fresh vs. aged bark to determine if fertilizer practices should be changed when using either type.

Results:

Bark samples are currently being collected from bark suppliers every 2 months. Samples are being collected from piles of fresh and aged bark. Samples are being analyzed for extractable micro- and macro-nutrients, particle size distribution, percent air space, percent water holding capacity, percent pore space, and moisture release curves. Thus far our data indicates that there are minor differences in the physical properties of fresh and aged bark. The results with some bulleted discussion points are provided in Appendix 1.

We have also been documenting the chemical properties of Douglas fir bark (reported in Appendix 2). We have noticed subtle, but potentially important, differences in pH of Douglas fir bark. Bark, as expected, is almost void of nitrogen. We learned that there are alarmingly high rates of extractable phosphorus in both fresh and aged bark. Grants for 2006 will be submitted to address these issues. Calcium, magnesium, and sulfur levels were very low. However, most nursery growers apply some level of dolomitic lime that compensates for levels of calcium and magnesium, and many fertilizer supplements contain sulfates as a component.

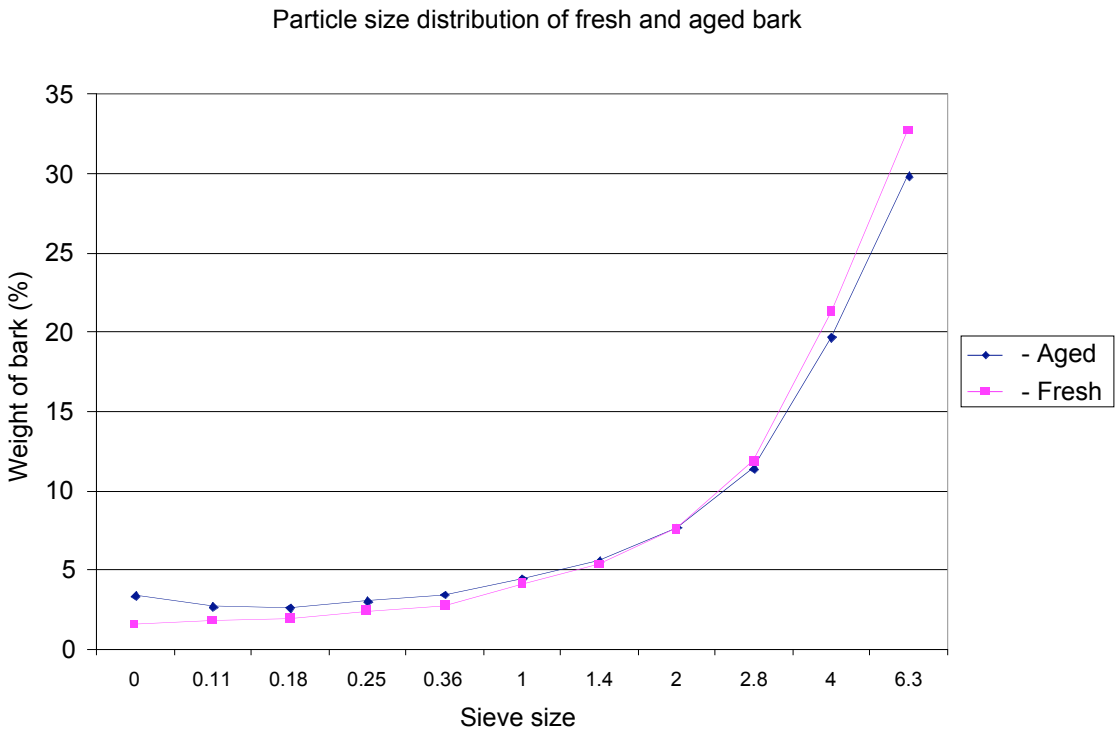
An experiment was conducted to determine the influence of bark type (fresh vs. aged) on geranium (*Pelargonium* x *hortorum* 'Maverick Red') growth. Geraniums were grown in #1 pots and fertilized with 100, 200, or 300 ppm N using ammonium nitrate. Data

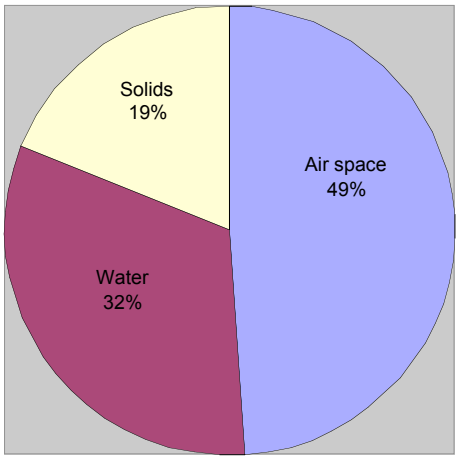
collected included plant size (measured as shoot dry weight (SDW)), plant chlorophyll with a SPAD 502 meter, and foliar nutrients determined with standard laboratory procedures. Plants were grown for 8 weeks before harvesting. Data are presented in Table 2 of this report. Plants growing in fresh bark were smaller, had less chlorophyll, and had lower levels of available N than plants growing in aged bark. These differences were likely caused by greater N immobilization in fresh bark. Experiments funded by a different grant are currently underway to determine the quantity of N immobilized in fresh and aged bark. Ultimately, this will allow us to make recommendations on how much additional N needs to be added to fresh bark in order to compensate for the greater amounts of N immobilization.

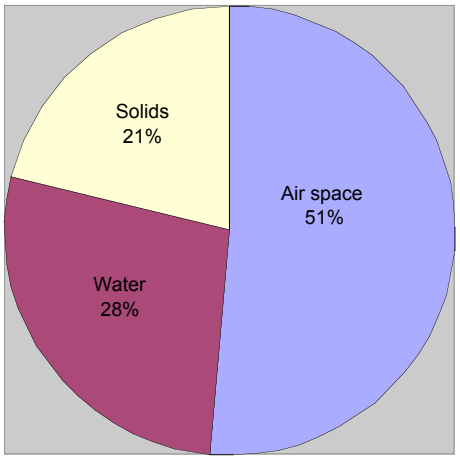
We found that fresh and aged Douglas fir bark collected directly from the bark suppliers has sufficient levels of extractable micronutrients for plant growth, without amending with other components or fertilizers. These results are reported in Appendix 2 of this report.

A greenhouse experiment was also conducted to determine if levels of micronutrients in fresh and aged Douglas fir bark were sufficient to support plant growth. Annual vinca (*Catharanthus roseus*) were grown in #1 containers for 8 weeks using fresh or aged Douglas fir bark amended with either Micromax micronutrients (an industry standard source for micronutrients), compost, or nothing. All containers uniformly received sufficient macro and secondary nutrients from Osmocote 18-6-12 and dolomitic lime. Annual vinca growing in fresh or aged Douglas fir bark with no micronutrient fertilizers grew as well as those in substrates amended with some form of micronutrient fertilizer. This experiment was repeated twice, with similar results each time. Plants growing in fresh bark were smaller due to reduced available N levels (as discussed above with geranium), however, micronutrient levels were sufficient for all crops. There were higher levels of some micronutrients in tissue of plants growing in aged bark, but this is likely due to lower pH of those substrates. See Table 3 for a summary of these results.

Appendix 1: Physical Properties of Douglas fir Bark







Aged Bark	**Fresh Bark**

Fresh bark has slightly larger particle size compared to aged bark.

Fresh bark has slightly more air space and less water holding capacity than aged bark.

Differences in physical properties of fresh and aged bark are negligible. We can measure the differences, but they don't appear to be important.

Appendix 2: Chemical Properties of Douglas Fir Bark

Table 1. Macro and micro-nutrient levels in fresh and aged bark.

	Water extraction (ppm)									DTPA extraction (ppm)			
Type	pH	Salt	P	K	Ca	Mg	SO4	B	Na	Fe	Mn	Cu	Zn
Aged	4.0	356	**18.4**	**93.1**	29.3	20.8	12.4	**0.24**	**11.3**	**74.8**	**8.2**	**0.3**	**2.5**
Fresh	4.7	289	**17.0**	**105.5**	20.0	9.3	13.9	**0.14**	**11.6**	**25.9**	**11.0**	**0.3**	**2.3**
Difference	*	NS	NS	NS	NS	*	NS	*	NS	*	*	NS	NS
Ideal	5 - 6		5 - 10	50 - 200	150 - 250	20 - 80	50 - 250	0.06 - 0.6	0 - 80				

The pH of aged bark is lower than that of fresh bark. This is not terribly important, as most nurseries typically incorporate lime into the substrate prior to potting. If this difference in pH proves to be consistent, it may mean that different liming practices should be recommended for the two bark types.

Levels of phosphorus (P) are similar for fresh and aged bark. However, both are very high. This leads us to question the common practice of adding high levels of P fertilizer to containers. We have submitted a grant to the USDA study this next year.

There are no differences in available potassium (K), and levels are within the ideal range.

Calcium (Ca) and magnesium (Mg) levels are similar, although much lower than recommended. This isn't terribly important, as again most growers are incorporating lime into their bark, and most irrigation water in the Willamette Valley has moderate to high levels of dissolved Ca and Mg.

There are differences in the level of boron (B), however, this difference is relatively unimportant.

There are differences in the levels of available iron (Fe) and manganese (Mn). As far as we could find, there aren't any 'ideal' ranges specified in the literature. But what is more important than the level of each, is the ratio of Fe:Mn. This ratio should be around 2 (Fe should be 2 times the level of Mn); however, the ratio for aged bark is approximately 9. This doesn't seem to have caused any problems in the nursery industry, but we will look into this with future research.