Final Report

Oregon Department of Agriculture and Oregon Association of Nurseries
Nursery Research 2011 Project Pre-Proposal

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Title: Integrating selected alternative substrates for woody ornamental container production: From substrate properties to cultural management.

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Project background and/or justification
Bark and peat alternatives for containerized crop production continue to be identified as a top research priority by Oregon nursery growers. Douglas fir bark remains a concern to growers because of potential issues with availability, consistency, and cost. Soilless substrate produced from readily available regional biomass can potentially provide a sustainable, peat-free, reproducible and cost effective alternative. Regionally available biomass from culled Christmas trees, culled shade trees, grass seed straw, and poplar, as well as a potential Pacific Northwest biomass producer such as bamboo, have undergone screening in greenhouse trials in winter of 2009-2010 to investigate the physiochemical properties of the substrate and subsequent crop response. Furthermore, research trials on woody ornamental crops were conducted in the summer of 2010 to better understand the dynamics of each alternative substrate. Data collection and analysis from these trials is underway, however preliminary results show Douglas fir slash and culled Christmas trees have the greatest promise as an alternative substrate due to ease of integration into existing production practices and increased availability due to Oregon burning law revisions. Culled shade trees and grass seed straw warrant continued research as a soilless substrate alternative since they are currently abundant in the Northern Willamette Valley and pose a possible disposal issue now and in the future. Pine slash and hybrid poplar sawdust or chip also show promise, however there remains concerns regarding cost feasibility due to the distance material needs to be shipped. Lastly, bamboo as a substrate shows promise, however, use remains in its infancy due to lack of understanding of production, biomass yield, and overall cost feasibility.

Preliminary screening of the aforementioned substrate alternatives has been completed to ensure no phytotoxic effects, as well as estimating stability (how much it shrinks) . There was also a need to research the alternative substrates physiochemical properties and subsequent effect on production practices. This information will assist in integrating these alternatives into the nursery industry as bark extender or replacement and a potential replacement for peat.

Project objectives

The project objective is to identify cost effective, readily available biomass products and engineer alternative soilless substrates to extend or replace Douglas fir bark within the Willamette Valley. This is a multiyear objective that must also consider ease of product integration into the nursery industry. In 2011 we would like to continue moving towards this objective by:

1) investigating the effect of organic and non-organic amendment on substrate physical properties,
2) investigating pH dynamics of alternative substrates and Douglas fir bark or peat mixtures, and
3) determine nitrogen removal of varying alternative substrates and subsequent effect of crop growth.

This research would focus on the utilization of hammer-milled Douglas fir slash and culled Christmas trees. Exploratory research would continue on other alternative substrate materials including but not limited to, poplar, bamboo, culled shade trees, pine slash.

Results

Table 1. Physical Properties of soilless substrates used to investigate pH and nitrogen dynamics.

Percent by volume	Water holding capacity	Air space	Total porostiy	Bulk density: container capacity	Bulk density: after drying
	----- percent volume ------			--- g / cm ---	
			Douglas fir bark		
Control (100%)	32	46	77	0.56	0.25
			Douglas Fir Slash		
33%	40	47	87	0.59	0.19
66%	38	51	89	0.55	0.17
100%	32	54	86	0.50	0.19
			Culled Christmas Tree		
33%	39	51	90	0.55	0.16
66%	38	54	91	0.52	0.14
100%	32	61	93	0.44	0.12

pH Adjustment: To evaluate how the pH of alternative substrates affect plant growth, an experiment was initiated using Cotoneaster 'Coral Beauty'. Varying ratios of Douglas fir bark to Douglas fir slash or Douglas fir bark to Christmas tree were used from 33 to 100%. In addition to the 4 ratios of alternative substrate to Douglas fir bark, 3 rates of lime were incorporated for a total of 20 treatments. Bimonthly pour- throughs were completed to observe the effect of lime rates on pH of the substrate solution for each lime rate in each substrate type. Leaching fractions were used to maintain adequate irrigation. Final observations and photos were taken at experiment termination.

Table 2 pH of soilless substrates comprised of varying ratios of alternative components and Douglas fir bark when amended with 0 to 9 lb/yd of lime.

Percent Substrate	Lime rate	Date						
	lb /yd	27-Jun	11-Jul	25-Jul	5-Aug	18-Aug	1-Sep	15-Sep
				Douglas fir bark				
100	0	6.54	5.27	4.59	4.43	5.39	5.27	4.20
				Douglas fir slash				
33	3	6.62	6.57	6.37	6.17	5.71	5.95	6.14
	6	7.10	6.90	6.72	6.12	6.14	6.18	6.51
	9	7.07	7.43	6.81	6.43	6.37	6.50	6.62
66	3	7.22	7.23	6.62	6.36	6.05	6.28	6.82
	6	7.04	7.33	7.18	6.20	6.41	6.58	6.66
	9	6.85	7.73	7.35	6.77	6.45	6.71	6.88
100	3	7.20	7.50	7.03	6.59	6.30	6.27	6.68
	6	7.66	7.63	7.53	6.88	6.85	6.88	7.09
	9	7.41	7.73	7.57	7.16	6.92	7.14	7.09
				Culled Christmas tree				
33	3	6.59	6.53	6.67	6.17	6.30	6.29	6.21
	6	6.85	7.03	7.26	6.27	6.31	6.45	6.60
	9	7.17	7.17	6.96	6.61	6.55	6.34	5.88
66	3	7.21	7.17	7.11	6.71	6.42	6.61	6.36
	6	7.31	7.35	7.32	6.68	6.43	6.87	6.66
	9	7.28	7.40	7.62	6.93	6.68	6.88	6.81
100	3	7.35	7.47	7.60	7.02	6.75	6.67	6.71
	6	7.50	7.70	7.92	7.05	6.77	6.79	7.11
	9	7.61	7.87	7.86	7.16	6.79	6.75	7.12

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Nitrogen Dynamics: Two studies were undertaken to investigate the relationship between Christmas tree and Douglas fir slash alternative substrates and nitrogen rates on plant growth for a herbaceous and woody ornamental crop. Azaleas were chosen to represent the woody crop due to the visibility of foliar deficiency symptomology in past experiments. Marigold were chosen for the herbaceous crop due to grower recommendations as an indicator. For both experiments, four fertilizer rates were applied to 3 substrate types (Douglas fir bark, Christmas tree, Douglas fir slash). The alternative substrates were comprised of mixtures of multiple screen sizes of hammermilled material that produced the optimal physical properties. To evaluate the effect the alternative substrates had on nitrogen availability, shoots were rated, tissue samples were collected and analyzed for nutrient content and shoot dry weight was determined and compared across treatments.

Table 3. Rhododendron response to varying levels of nitrogen grown in soilless substrates comprised of varying ratios of alternative components and Douglas fir bark.

Nitrogen Rate lb/yd	Shoot weight g	SE g	Plant rating 1 to 5 (5 being best)	SE
		Douglas fir bark (control)		
0.0	14.69	2.15	3.00	0.26
1.5	19.41	2.07	3.67	0.21
3.0	25.44	3.75	3.83	0.40
6.0	27.48	2.57	4.00	0.26
		Douglas fir slash		
0.0	10.27	0.84	2.43	0.32
1.5	16.90	3.86	3.00	0.33
3.0	18.16	1.69	3.57	0.40
6.0	19.41	1.28	3.86	0.15
		Culled Christmas tree		
0	9.10	0.39	2.14	0.28
1.5	10.70	0.61	2.57	0.22
3	13.12	1.65	3.43	0.22
6	16.76	1.12	3.29	0.31

Peat and Pumice Amendments: An experiment to evaluate the effect alternative substrate particle size has on physical properties and how this impacts plant growth was initiated using Rhododendron PJM. This plant species was chosen due to its sensitivity to substrate porosity. To produce substrate mixes with various physical properties, both Christmas tree and Douglas fir slash were hammermilled into either coarse or fine particles. Varying proportions of each were combined with proportions of horticultural peat and/or pumice. Irrigation was maintained with monthly leaching fractions and chemical properties were monitored via pour-throughs. To evaluate the effect of the substrates with different particle sizes, top growth was harvested, dried and weighed. Photos and final observations were also taken at this time.

Table 4. Plant response of rhododendron grown in soilless substrates comprised of Sphagnum peat, pumice and varying ratios of alternative components at different particle sized and Douglas fir bark.

Particle size of alternative		Sphagnum	Screened	Avg. Shoot	Standard
Coarse	Fine	peat	pumice	weight	error
% vol.	% vol.	% vol.	% vol.	grams	grams
		Culled christmas tree			
40	30	30	0	12.01	1.44
40	45	15	0	11.66	1.49
40	30	15	15	11.10	1.42
		Douglas fir slash			
40	30	30	0	13.28	1.50
40	45	15	0	14.14	1.29
40	30	15	15	16.63	1.07