Washington State University Bamboo Research Report 2002

On-Farm Bamboo Production In The Pacific Northwest

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Our on-farm bamboo study in Washington was planted in the fall of 1997, and in 2000 maximum culm diameter, plant height and plant spread increased substantially for most varieties. In 2002, many of the plants had spread throughout their respective plot so that there was little weeding that needed to be done within the plots. Plants in this study have not yet produced marketable shoots or poles; we expected this would take at least 5 years under the best of conditions, which includes optimum plant nutrition and irrigation. I invite all who are interested to visit the study, either individually or in groups. Just let me know and I will be glad to make arrangements with the farm for your visit.

In 1999, bamboo research at WSU was expanded to WSU Puyallup. In 2000, bamboo research was expanded to WSU Vancouver. At Vancouver, we planted 1 or 2 plants each of 14 varieties. We moved these plants from the Northcraft farm so that we could have easy access to bamboo for future studies. Scientists at WSU Vancouver are interested in pest control, as well as general plant establishment and growth in a farm situation. In 2002, we revised and reprinted our bamboo shoot brochure, we revised our web page on bamboo suppliers, we included bamboo in a Riparian Zone Enhancement project that is funded by the Washington Department of Ecology (10 plants of *Chusquea culeo* were donated by Jackie Heinricher for this project), and the Washington State University Center for Sustaining Agriculture and Natural Resources (CSANR) funded me to travel for two days with Daphne Lewis to visit bamboo farms and businesses in the Seattle region.

In 2002, I did not request renewed funding from the ABS or the regional chapters for the bamboo study in Tenino. The planting in Tenino is relatively well established at this time and requires only 2-3 days of labor for plot maintenance and data collection. With the help of students, it is possible to do this in 2004 without the financial support of the bamboo societies. Our Riparian Enhancement project in Vancouver is also funded through other grants (DOE). Andy Bary has requested your support for his replicated bamboo trial in Puyallup. With the limited funding available through the ABS and the regional chapters, I felt it was more essential for the societies to fund the new replicated study in Puyallup, and I will fund the Tenino trial through other means.

Background
In October 1997, 28 bamboo varieties were established in on-farm research plots at the Northcraft Farm in Tenino, Washington. A total of 89 plants were planted in 46 plots. Plots measure 8 ft. by 8 ft., and 8-foot alleyways separate plots on all sides. The total area of this study is 0.37 acres. Alleys are maintained between plots by mechanical cultivation for weed control and to prevent future spread of bamboo into neighboring plots. Weed control within plots is by hand cultivation. The farm is organic so no pesticide applications or synthetic fertilizers are used. Dairy manure and chicken manure were applied to the plots to meet plant nutrient needs and as a mulch to help control weeds.

The trial site is a seasonally flooded pasture and is highly typical of much of the farmland in the Pacific Northwest. Annual rainfall accumulation at the trial site is approximately 45 inches. Rainfall is generally from October through April, and soil throughout the trial is 80-100% saturated December through March. Bamboo in this study receives no supplemental irrigation at any time. The trial site was specifically selected to investigate the suitability of bamboo for these farming conditions.

Projected outcomes

- Variety recommendations for shoot and pole production for the Pacific Northwest
- Guidelines for sustainable cultural practices and soil fertility management for small-scale
  commercial field production in the region
- Bamboo shoot marketing and consumption information

Procedures for 2002
Data Collection. On October 15, 2002 we measured maximum plant height, plant spread (maximum distance between culms within a plot), maximum diameter of culms (5 largest culms of each plant), and observed general plant health.

Weed Control. Weeds have been a major issue at this site, as they are in many old pastures, and thistles and perennial grasses are persistent. Weeds are no longer a major issue within the plots as the bamboo has become well enough established that it shades out the weeds in the center of the plots. The farm manager maintains good weed control in the alley-ways by tillage. He has also used flaming to control weeds around the perimeter of the plots. Weeding is most difficult around the perimeters of the plots as we do not till too closely to the plants as this will cut new extending rhizomes.

Manure Application. Bamboo is shallow-rooted, is likely a heavy nutrient feeder, and we believe it may respond well to manure applications. In this study, dairy and poultry manures were used as a source of plant nutrients and organic matter, and as a mulch. Manure was applied around bamboo plants at planting in 1997, and in the spring and fall of 1998–2002 . At each application, we applied 2-3 inches of manure around each plant. In 1997, 1998, and spring 1999, dairy manure was applied at a rate of 10 gallons (by volume) per plant, equivalent to 44-50 pounds total nitrogen per acre. In the fall of 1999 that amount was increased to 20 gallons per plant. In

2000–2002, dairy and poultry manures were applied at rates of 15 and 5 gallons, respectively, per plot. Fresh manure should not be applied to bamboo within 120 days of shoot harvest (Rangarajan et al., 2000). Growers must pay particular attention to food safety issues associated with potential pathogens when manure is used for human food crop production.

Results and Discussion

Table 1 is a summary of our growth measurements and observations on October 15, 2002. In general, 10 varieties are growing vigorously in this non-irrigated site and appear to be well suited for pole and shoot production: *P. congesta*, *P. bissetii*, *P. vivax*, *P. dulcis*, *P. megurochiko*, *P. rubromarginata*, *P. nigra henon*, *P. humulis*, *P. heteroclada* 'solid stem' and *P. heteroclada* 'water bamboo.' *P. bissetii*, *P. congesta*, *P. vivax*, and *P. dulcis* produced the largest culms and the healthiest plants in this study. Other varieties are growing well, such as *P. aurea*, *P. bambusoides* and *P. meyeri*, but they are not the most vigorous at this site. Culms are not large enough for harvest at this time and we made no evaluations of shoot flavor or quality, or for pole quality.

Plants of four varieties – *P. atrovaginata*, *P. a. alata*, *P. bambusoides 'Castillon'*, and *P. nigra* – are dead in the study plots. *P. atrovaginata* and *P. bambusoides* 'Castillon' have been dead since fall 1999. *P. a. alata* and *P. nigra* have been dead since spring 2000, potentially due to the heavy frost in January 2000.

Two varieties, *P. rubromarginata* and *P. flexuosa*, have flowered over the course of the study. There were seven plants of *P. rubromarginata* in this study, and two of these plants flowered in 1999-2000. Of the two plants that flowered, one was dead and the other was near dead but had several new growth points in August 2000. This plant was still alive in October 2002 but not thriving. There were two plants of *P. flexuosa* in this study and both flowered and appeared to be dieing in August 2000. By October 2002, both plants were dead.

P. Congesta had appeared dead to us in previous years, but in 2000 it showed new growth. By October 2002, this plant was quite vigorous and indeed was one of the most vigorous plants in the study.

Culm measurements. Table 2 is a summary of the number of culms and culm diameter measurements from 1997 to 2002. In 1999 we stopped measuring the number of culms as most varieties produced dozens of thin, small culms that were too numerous to count in an effective manner. Varieties that had the greatest increase in culm diameter were *P. bissetii* (24mm, 678%), *P.dulcis* (16 mm, 365%), *P. vivax* (17 mm, 340%), and *P. congesta* (19 mm, 261%). One variety, *P. aureosulcata*, had a decline in culm diameter. Plants of this variety had larger culms when they were transplanted into the plots, and these large culms have since died. This variety has produced numerous but thinner new culm growth.

Plant spread. Plant spread (farthest distance between culms) increased for all varieties (Table 3). Since 2000, plants in several of the plots have grown together, so that plant spread measurements in those plots are no longer for individual plants but are for whole plots. Differences in rates of plant spread will be useful when determining how closely different varieties should be spaced in the field to achieve optimum ground coverage in a reasonable amount of time. Growers do not

want to over-plant bamboo as it is too expensive. At the same time, optimum ground coverage is desirable as the longer the ground is not covered with bamboo, the longer it will be covered with weeds. Weed control is probably the single greatest expense for field maintenance of most crops, including bamboo.

For example, from this study we can see that *P. humilis* spread 4.3 meters within 5 years whereas *Pseudosasa japonica* only spread 0.7 meter. If I were to translate these observations to grower recommendations, I might say that a grower would need fewer plants of *P. humilis* than of *Pseudosasa japonica* to plant a 100-foot row. Since these are not replicated field plots, we cannot say these are scientific conclusions but rather they are only observations based on a few plants.

The other important issue to keep in mind with any results that are generated from studies (whether or not they are replicated plots) is that conclusions can only be drawn for the specific environment in which the study was conducted. So I hesitate to expand our results to other areas of the Pacific Northwest where temperatures, light, and precipitation/moisture will be different. With that said, this study has given us some good ideas of how varieties may perform differently in the region.

In this study, the variety with the greatest plant spread was *P. humilis* (4.3 m, 14 fold increase). Other varieties with large plant spread were *P. heteroclada* - water bamboo (4.1m, 25 fold increase), *P. bissetii* (4 m, 20 fold increase), and *P. aurea* (3.4 m, 14 fold increase).

Plant Height. Varieties that had the greatest plant height were *P. congesta* (4.1 m, 1.9 fold increase), *P. humilis* (3.9 m, 1.2 fold increase), *P. nigra* 'henon' (3.9 m, 2.5 fold increase), and *P. vivax* (3.8 m, 2.4 fold increase). Three varieties, *P. aureosulcata*, *Fargesia nitida*, and *P. meyeri*, had a decline in plant height. These plants had taller culms when they were transplanted into the plots, and these large culms have since died. These varieties have produced numerous but smaller new culms.

Bamboo shoot brochures and recipe cards

In spring 2000 we developed marketing brochures and recipe cards to promote the sale and consumption of locally produced bamboo shoots. In 2000, we printed 2000 copies of the brochure and in 2002 we printed another 1000 copies of the brochure. We also printed 500 copies each of 4 recipe cards in 2000. We have distributed brochures and recipe cards to colleagues, growers, and consumers at regional and national workshops and conferences. It is our intent that these brochures and recipe cards will provide consumers with easy-to-follow cooking instructions for bamboo shoots, as well as general information about locally produced food. Through our programs we are promoting consumption of locally produced food, and by providing healthy and tasty cooking instructions, we hope to increase repeat purchasing.

The brochure and recipes are available on our website and we encourage growers to reprint and distribute them. We also encourage you to personalize and reformat the brochures and recipes to suit your needs. We do ask however, that you reference our WSU program as a source for this information.

Web site
In the summer of 2002, Amanda Johnson, a student working with me for the summer, updated our web page Bamboo Suppliers, http://agsyst.wsu.edu/bambiz.htm.

Future Work
- Continue data collection on plant growth at Northcraft Farm
- Develop publication with Daphne Lewis
  - Guidelines for on-farm bamboo production
- Maintain, update, and expand web pages as needed

References
Rangaragan, A., E.A. Bihn, R.B. Gravani, D.L. Scott, and M.P. Pritts. 2000. Food safety begins on the farm – a grower's guide. Good Agricultural Practices for Fresh Fruits and Vegetables. Cornell University, (607) 254-5358.

Table 1. Maximum height (feet), culm diameter (cm) and plant spread of bamboo varieties in Tenino on-farm plots on October 15, 2002.

Genus species	Max. height (ft)	culm diameter (cm)	Plant spread (ft)	General health; and Shoot/Pole Suitability (Yes, No, Maybe)
S. fatuosa viridis	7.2	2.2	8.0	yellow, slow runner; No
F. nitida	7.2	1.0	4.0	small, low spread; No
P. aurea	6.2	1.0	12.0	small, bushy, dense spread; Maybe
P. aurea	6.5	1.2	10.0	small, clumplike, some rhizome spread; No
P.aurea *mean*	*6.4*	*1.1*	*11.0*	
P. bambusoides	9.0	1.4	7.0	sparse, little growth, slow growing; Maybe
P. bissetii	12.0	1.6	14.0	good fill, height, color and spread, runner; **Yes**
P. bissetii	12.5	4.0	8.5	nice color, size & height, compact, uniform spread; **Yes**
P. bissetii *mean*	*12.4*	*2.8*	*11.2*	
P. congesta	13.5	2.6	12.2	large culms, good size, spread, height and fill; **Yes**
P. dulcis	10.2	2.0	6.0	few culms, good size, sparse, low spread; **Yes**
P. heteroclada-soild stem	10.2	1.6	9.5	dense, clump-like; **Yes**
P. heteroclada-waterbamboo	9.7	1.4	14.0	good spread, nice size, runner; **Yes**
P. heterocycla pubescens	7.2	1.0	8.0	small, yelow non-runner; No
P. humulis	13.2	1.6	14.0	good size and height, virogous spread; **Yes**
P. humulis	12.7	1.6	16.5	good spread and height, OK culm, runner; **Yes**
P. humulis *mean*	*1.0*	*1.6*	*15.2*	
P. megurochiku	1.2	0.5	2.0	very small; No
P. megurochiku	11.5	2.0	14.0	good size and height, runner; **Yes**
P. megurochiku	14.0	2.0	7.5	good height, no spread, nice culm size; **Yes**
P. megurochiku *mean*	*8.9*	*1.5*	*7.8*	
P. meyeri	9.5	1.2	10.0	yellow, clump, OK; Maybe
P. nigra bory	12	1.8	17.0	good size and height, not dense, runner; Maybe
P. nigra bory	5.2	0.9	3.0	small; No
P. nigra bory *mean*	8.6	1.3	10.0	
P. nigra henon	12.7	2.0	8.5	good size and height, OK spread; **Yes**
P. nigra henon	14.0	1.8	12.5	dense, good size culms, good color, runner; **Yes**
P. nigra henon	12.0	1.6	11.5	nice culm size, good spread, height, fill and color; **Yes**
P. nigra henon *mean*	*12.9*	*1.8*	*10.8*	
P. rubromarginata	14.0	1.8	11.5	yellow culms, good size and height, slow spread; **Yes**
P. rubromarginata	9.5	2.0	6.5	dense, little spread, clump-like; No
P. rubromarginata *mean*	*11.7*	*1.9*	*9.0*	
P. vivax	12.5	2.2	9.0	large culms, sparse spread; **Yes**
Platyglossa	6.0	0.9	8.0	short, small; No
Pseudosasa japonica	4.5	1.0	3.5	no spread, short; No
P. purpurata straightstem	9.0	1.6	10.0	thin, sparse, slow runner; Maybe

Table 2. Mean number of bamboo culms, maximum culm diameter (mm), change in maximum culm diameter (mm), and % change in maximum culm diameter from 1997 through 2000 at our on-farm research site in Tenino, Washington.

	No. of Culms		Maximum Culm Diameter				Change in	%
Genus species	Dec-97	Jul-98	Sep-99	Apr-00	Aug-00	Oct-02	culm diam.	change
Fargesia dracocephala	n/a	14.7	n/a	1.5	2.3	N/a	0.8	53
Fargesia nitida	4.5	17	7	5.5	8.1	10	3	43
P. atrovaginata	2.8	7	n/a	n/a	n/a	dead	dead	dead
P. aurea	2.8	15.8	4.8	3.3	9.1	10	5.2	108
P. aureosulcata	5	10	8.2	7.7	7.8	N/a	0.1	-5
P. aureosulcata alata	3	9	2.4	n/a	n/a	dead	dead	dead
P. bambusoides	2.5	9.5	4.9	3.5	9	14	9.1	186
P. bambusoides 'Castillon'	1	1	dead	dead	dead	dead	dead	dead
P. bissetii	3.7	14.3	3.6	3.3	6.6	28	24.4	678
P. Congesta	n/a	n/a	n/a	7.2	9.3	26	18.8	261
P. dulcis	2.3	7.3	4.3	3	11.3	20	15.7	365
P. flexuosa	5	9.5	3.1	1	3	dead	dead	dead
P. heteroclada (Water bamboo)	3	6.5	4.5	6	8.8	14	9.5	211
P. heteroclada 'Solid Stem'	2.5	8.5	6.4	5.1	9.5	16	9.6	150
P. heteroclada 'Straightstem'	2	2	7.9	5.4	8.2	16	7.8	99
P. heterocycla pubescens (Moso)	3	11.8	4.4	2.4	0.7	10	5.6	127
P. humilis	3.2	10	9.2	9.1	10.2	16	6.8	74
P. meyeri	5.3	9	5.8	4.8	6.7	12	6.2	107
P. nigra	1.3	10.3	n/a	dead	dead	dead	dead	dead
P. nigra 'Bory'	3.3	5.5	4.8	2.8	7.3	13	8.7	181
P. nigra 'Henon'	3.3	7.9	5.8	4.1	9.8	18	12.2	210
P. nigra 'Megurochiku'	3	8.5	5.4	3.7	8.7	15	9.6	178
P. platyglossa	2.5	3	n/a	2	2.5	9	6	200
P. rubromarginata	4.8	10.7	7.1	6.8	10.1	19	11.9	168
P. vivax	1.5	2.5	5	3.5	7.8	22	17	340
Pseudosasa japonica	5	34	4.1	3	7.6	10	7	171
Semiarundinaria fastuosa viridis	2.5	9	7.8	5.5	11.7	22	2.5	32

Table 3. Plant spread (cm), change in plant spread (m), and % change in plant spread from 1997 through 2000 at our on-farm research site in Tenino, Washington.

	Plant Spread					Change in		Plants
Genus species	Jul-98	Sep-99	Apr-00	Aug-00	Oct-02	Plant Spread (m)	% change	grown together
Fargesia dracocephala	7	17.8	15	20	N/a	0.1	186	
Fargesia nitida	42.8	62.7	70	71.7	122	0.8	185	
P. atrovaginata	16.7	35.1	dead	dead	dead	dead	dead	
P. aurea	23.7	49.1	47.5	121.7	366	3	1444	
P. aureosulcata	52	66	42.5	80	N/a	0.3	54	Yes
P. aureosulcata alata	19.5	95.3	dead	dead	dead	dead	dead	
P. bambusoides	11.5	30.5	27.5	170	213	2.0	1756	Yes
P. bambusoides 'Castillon'	2	dead	dead	dead	dead	dead	dead	
P. bissetii	20.2	62.2	77.5	223.3	427	4.1	2014	Yes
P. Congesta	n/a	n/a	34.3	84	374	3.4	989	Yes, 1 out of 3 plots
P. dulcis	18.8	28.6	27.8	123.3	183	1.6	873	
P. flexuosa	25	34.3	30	37.5	dead	dead	dead	
P. heteroclada (Water bamboo)	16	83.8	77.5	205	427	4.1	2569	
P. heteroclada 'SolidStem'	24	n/a	85	220	290	2.7	1107	Yes
P. heteroclada 'Straightstem'	16.5	46.4	40	280	305	2.9	1748	
P. heterocycla pubescens (Moso)	30.8	67.3	62.5	215	244	2.0	692	Yes
P. humilis	31.8	67.3	84.2	184	465	4.3	1363	Yes, 1 out of 3 plots
P. meyeri	25	39.8	52.5	63.3	305	2.8	1120	
P. nigra	10	24.1	dead	dead	dead	dead	dead	
P. nigra 'Bory'	12.8	44	40	143.3	259	2.0	1925	
P. nigra 'Henon'	21.1	38.1	48.9	250	330.	3.1	1464	Yes
P. nigra 'Megurochiku'	23.5	52.1	54	166.3	239	215.4	917	Yes, 1 out of 3 plots
P. platyglossa	4.5	11.4	45	42.5	244	2.4	5322	
P. rubromarginata	21.7	25.1	28.6	99.2	274	2.5	1165	
P. vivax	11	19.1	16.3	95	274	2.6	2395	
Pseudosasa japonica	33.5	61	55	60	107	0.7	219	
Semiarundinaria fastuosa viridis	16.5	48.3	55	80	244	2.3	1379	

Table 4. Maximum plant height (m), change in plant height (m), and % change in height from 1997 through 2000 at our on-farm research site in Tenino, Washington.

	Maximum Plant Height						Change in	
Genus species	Dec-97	Jul-98	Sep-99	Apr-00	Aug-00	Oct-02	Height	% change
Fargesia dracocephala	0.5	0.6	0.3	0.2	0.6	N/a	*0.1*	*20*
Fargesia nitida	2.3	2.3	2.2	2.3	2.1	2.2	*-0.1*	*-5.*
P. atrovaginata	1	1.3	dead	dead	dead	*dead*	*dead*	*dead*
P. aurea	1.6	1.9	1.5	1.5	2	1.9	*0.3*	*73*
P. aureosulcata	2.4	2.5	2.2	2.3	2.2	N/a	*-0.2*	*-8*
P. aureosulcata alata	2.5	2.9	1.1	dead	dead	*dead*	*dead*	*dead*
P. bambusoides	0.8	0.9	1	0.9	2.7	2.7	*1.9*	*237*
P. bambusoides 'Castillon'	0.5	0.5	dead	dead	dead	*dead*	*dead*	*dead*
P. bissetii	1	1.2	0.3	1.1	2	3.7	*2.7*	*267*
P. Congesta	n/a	n/a	n/a	1.4	1.6	4.0	*2.6*	*189*
P. dulcis	1	1.6	1	1	2.3	3.1	*2.1*	*207*
P. flexuosa	1.6	1.7	0.8	0.8	0.7	dead	*dead*	*dead*
P. heteroclada (Water bamboo)	1.3	1.5	1.4	1.4	1.6	2.9	*1.6*	*125*
P. heteroclada 'SolidStem'	0.9	0.9	1.2	1.1	2.6	3.1	*2.2*	*242*
P. heteroclada 'Straightstem'	1.8	2.2	n/a	1.6	2.2	2.7	*0.9*	*50*
P. heterocycla pubescens (Moso)	1.6	1.6	0.8	0.3	2	2.2	*0.6*	*138*
P. humilis	1.7	2.2	2.3	2.2	2.9	3.9	*2.2*	*129*
P. meyeri	2.9	3.2	2.8	2	2.4	2.8	*-0.0*	*-2*
P. nigra	0.8	1.5	0.8	dead	dead	dead	*dead*	*dead*
P. nigra 'Bory'	1.2	1.4	1.4	1.4	2	2.6	*1.4*	*116*
P. nigra 'Henon'	1.1	1.9	1.8	1.8	2.8	3.9	*2.8*	*252*
P. nigra 'Megurochiku'	1.8	2.1	1.6	1.7	2.4	2.7	*0.91*	*50*
P. platyglossa	0.5	0.5	0.4	0.4	0.9	1.8	*1.3*	*260*
P. rubromarginata	2.1	2.2	2.2	2	2.4	3.5	*1.4*	*68*
P. vivax	1.1	1.6	1.2	0.9	2.4	3.7	*2.6*	*241*
Pseudosasa japonica	1	1.3	0.8	0.6	1.4	1.3	*0.3*	*35*
Semiarundinaria fastuosa viridis	1.4	1.5	1.3	1.3	2.6	2.2	*0.8*	*55*