FINAL PROJECT REPORT

Project Title: Field evaluation of new pear rootstocks

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Total Project Funding: $99,144.00

Budget History:

Item	Year 1: 2006	Year 2: 2007	Year 3: 2008
Salaries	15,239	17,508	19,850
Benefits	9,296	10,680	12,109
Wages	1,200	2,000	
Benefits	98	164	
Equipment			
Supplies	4,600	2,000	2,000
Travel	300	1,000	700
Miscellaneous	200	200	
Total	30,933	33,552	34,659

Objectives:

1) Initial screening and evaluation of the Horner rootstock series and evaluate untested rootstocks at OSU-MCAREC.
2) Comprehensive evaluation of the Horner rootstock series and untested rootstocks to be implemented in COS 2015 trials.
3) Identification of new rootstocks for future evaluation.

Significant Findings:

- A range of tree size (based on trunk cross-sectional area) exists in the Horner rootstock series, with a three to seven-fold difference exhibited in relative growth rates.
- Horner 4 produces a very vigorous tree [nearly the largest tree in all plantings, (i.e. both Horner screening and COS)], confirming earlier work.
- Precocious Horner selections have not yet been observed, although this could be due to poor climatic conditions during and immediately following bloom in multiple years of the study.
- DNA anlaysis of Horner 10 has confirmed that material used for propagation did derive from the mother plant (previously killed) at MCAREC.
- COS 'finished trees' reached the top wire in 2nd leaf (13 feet), however 3rd leaf (2008) fruit set was negligible, likely a function of poor climatic conditions during and immediately following bloom in 2008.
- COS 'bench-grafted trees' reached the top wire in 2nd leaf

Methods:

(1) Horner Rootstock Screening:
Three separate plantings (2004, 2005 and 2006) were made for the > 400 Horner selections, randomly planted (two or three single tree replicates), with 'd'Anjou' as the cultivar, and 'Bartlett' trees used as pollenizers. OHF 87 was used as a control in the 2005 and 2006 plantings. Trunk cross-sectional area (TCSA) was recorded in the fall.

(2) COS:
The goal to develop a mature fruiting canopy by the third leaf while allowing adequate light infiltration was accomplished using the following methods;

- Selections of P2535, Bet # 2291, 517-9, 708-13, 96FI11, 96FI12, 96FI14, 96FI15,
- Horner 4, OH 11, OHxF 87, Pyronia, and Q29859 were established.
- 'd'Anjou' (Horner 4, OHF87), 'Bartlett' (Horner 4, OHF 87, 69 and Fox 11), and 'Bosc' (Horner 4, OHF 69), were planted in a 12 ft x 4 ft vertical fruiting wall (907 trees/acre), 8-wire system with wires 18 inches apart, and a trellis height of 13 feet.
- Strategies for efficient shoot initiation and placement on wires were developed and implemented by notching combined with promalin application, at green tip, in years 2 and 3, and pinching of apical region throughout growing seasons to induce bud breaks.
- Labor hours for training and managing shoots were recorded.
- Irrigation was applied to optimize growth at two-2 hour sets per week (or as needed) in the 1st and 2nd leaf.
- Fertigation was applied bi-weekly totaling 16 lbs of actual Calcium Nitrate
- Yield and yield components, (fruitlets/flower bud and individual tree yields taken at harvest) will be used to measure progress (yield data will begin in 2009). TCSA has been collected annually.
- Old Home by Farmingdale 87 used as a control rootstock

Results and Discussion:

(1) Horner Rootstock Screening:

Yield began in the third year, and initial selections by the advisory committee were based on the limited amount of bloom and fruit set, with the hope that the 2007/08 harvests could clarify the choices. Of the entire Horner series, only 6, 2 and 1 of the selections from the 2004, 2005 and 2006 trials, respectively, fruited in 2008 (Tables 1-3). Due to poor fruit set this spring, evaluation of precocity and fruit set and their interactions with vegetative growth was not possible. Trunk cross-sectional area was recorded and expressed in both absolute and relative terms. Relative growth analysis $((TCA_{final} - TCA_{initial}) / TCA_{initial})*100$ was used to reduce the error associated with the large variability in trunk size at planting. There is roughly a three-four fold difference in vegetative growth across the series (Figure 1-3). Cumulative yields are also quite low for the selections, again as a function of severe spring temperatures that likely damaged blossoms and inhibited pollination, in both spring 2007 and 2008 (Tables 4-6). Annual and cumulative yield has been extrapolated to represent yield per acre with spacing of 10x16, (272 trees/acre). It should be noted that several selections had adequate blossom counts, so it appears that there is potential for precocity.

Pre-screening evaluations will continue for the Horner 2004, 2005 and 2006 plantings (funding solicited from Columbia Gorge Fruit Grower's Commission). Bloom density and fruit set data will be compiled in Spring 2009. In addition, the mother block of Horner rootstocks will be assessed to determine the value of re-selecting rootstocks based on expressed characteristics of vegetative growth (limb angle, relative vigor). For example, when viewing the stool bed, Horner 4 is by far the largest plant in the entire 400+ Horner series, consequently, it comes as little surprise that in two of the three plantings in which it has representation (2004, 2005) it transfers this effect to 'Anjou', and is the third largest of 285 selections and the largest of 146 selections in 2004 and 2005 plantings, respectively. Perhaps once fruit set occurs a shift in carbon partitioning will occur, favoring fruit growth. It is difficult to assess currently, in the absence of fruit, if selections such as Horner 4 are leading us in the opposite direction of the original objectives set forth by the committee, which were to advance precocious, size-controlling selections that could not only set adequate fruit numbers but size them as well. Based on a re-evaluation of the stool bed, selections will be moved forward for a more robust planting (i.e. with sufficient replication so that variability within a given selection can be accounted for). To achieve this goal, a minimum of eight replicates per selection will be required.

DNA anlaysis of Horner 10 has been completed. The results confirm that material used for propagation indeed derived from the mother plant at MCAREC. Two clones, Horner 4 and Horner 10, as well as OHxF 87 have been propagated at VanWell Nursery for on-farm trials. Currently, a total of 1,576 plants are available for distribution (comprised of Horner 4, 10 and OHxF 87, each stock worked with 'Bartlett', 'GR Bosc' and 'Anjou'). Dispersal of these materials to growers for on-farm trials beginning in spring 2009 are scheduled among three regions (Yakima, Wenatchee and Hood River).

(2) COS:

There is no yield data to date. Trees were expected to begin production in the 3rd leaf (2008), however severe spring temperatures limited fruit set. Vegetative growth as determined by TCSA, is beginning to show differences, with Horner 4 producing the largest tree for each of the three cultivars that are worked upon it. Horner 4 is roughly 33 % larger than OHF 69 for Bosc, roughly 10 % larger than OHF 69, 87 and Fox 11 (all producing trees of similar size) for Bartlett and approximately of equivalent size to OHF 87 for Anjou (data not shown). The main challenge to overcome in high density pear systems is managing vigor while trying to induce early yields, especially with Anjou. Proper light interception in the canopy is crucial to the success of high density plantings, so it is important to minimize growing points without causing excessive vegetative responses. Trees must be managed to fill only the space allotted to them without encroaching on their neighbor.

When employing techniques to encourage early fruiting, it is necessary to limit pruning in the early years. One of the drawbacks to planting feathered trees comes from the need to remove all limbs at planting time. This is necessary because they are usually 1) already too large and 2) located in the wrong place for training to the wire trellis. This pruning immediately promotes vegetative responses and may ultimately delay fruiting. In consideration of this problem benchgrafts and sleeping eyes were added to the trial for comparison. The advantage to these two types of material is the ability to initiate weak wood at the desired wire height by using notching and Promalin versus pruning.
The goal to grow a mature fruiting canopy was accomplished by the 3rd leaf. Developing a regular, intensive training regime to deal with shoot thinning and positioning before they became unmanageable was critical. It is expected that training intensity in the first three years will be offset by the timeliness of shoot positioning, and the wires will become the guide as the trees progress in later years. In the 2nd leaf, the trees were trained on a weekly basis to position shoots and encourage branching at the wires by pinching the terminal bud when it was 2-4 inches above the wire. The time spent in the 0.8 acre block averaged 64 hours a month during the growing season for the trees in their 2nd leaf. Less time in the 3rd leaf (average 40 hours month) was necessary to maintain the goal. Work was performed with ladders; a mechanical platform could simplify this chore.

Management strategies for managing vigor and encouraging earlier fruiting include;

- Minimal pruning and diligent timing of shoot removal
- Expedited pinching back terminal of buds to encourage branching as shoots grew past the wire.
- Notching above buds and applying Promalin to initiate bud break where shoots were absent.

Conversely, it was necessary to reduce growth by limiting irrigation and fertigation in the 3rd leaf.

- Deficit irrigation (a total of 6 hours of water this summer coupled with monitoring plant moisture stress with the pressure chamber) succeeded in controlling vigor, with OHxF 87 showing significantly better capabilities of withstanding water stress than OHxF69 (Figure 4). This strategy, however, would not be expected to work had a significant crop been present, without reducing fruit size. The severity of water withholding was based on hardening off shoot tips in the absence of fruit.
- Fertigation was limited to one spring application of Calcium Nitrate at the rate of 3.2 lbs actual N per acre.

Parameters such as yield efficiency (yield/unit TCSA) and flower density (flower buds/unit TCSA) will be used to begin analysis of rootstock and cultivar interactions in the 4th leaf.

There were survival issues with one of the three Khazakstan rootstocks, ‘Q 29858’. The rootstocks survived the first winter as sleeping eyes, but died in spring after bud break, possibly damaged by the early spring freeze. The other two, ‘Q29857’ and ‘Q29859’ have been budded and are doing well.

Figures

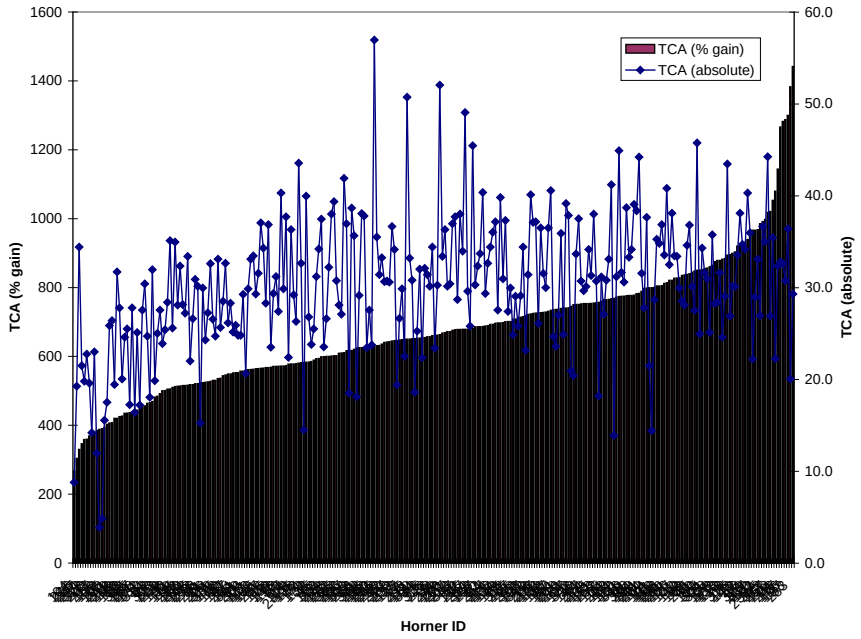

Figure 1. Range of tree size and growth across all selections (285) in Horner 2004 planting. Relative trunk cross-sectional area (TCA) as either % gain (from planting though Fall 2008) or in absolute terms (TCA as of Fall 2008, recorded in cm^2).

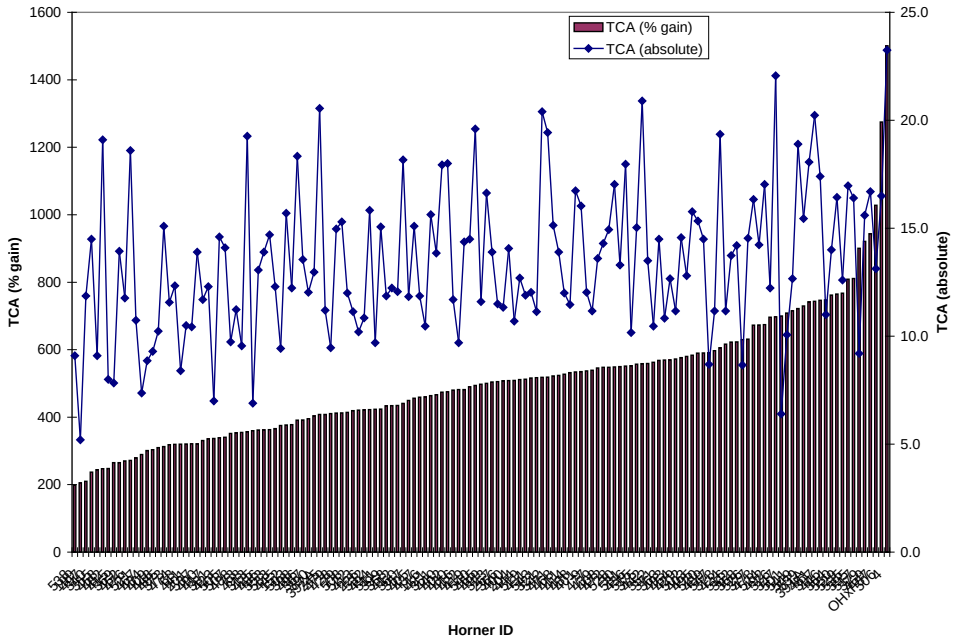

Figure 2. Range of tree size and growth across all selections (146) in Horner 2005 planting. Relative trunk cross-sectional area (TCA) as either % gain (from planting though Fall 2008) or in absolute terms (TCA as of Fall 2008, recorded in cm^2).

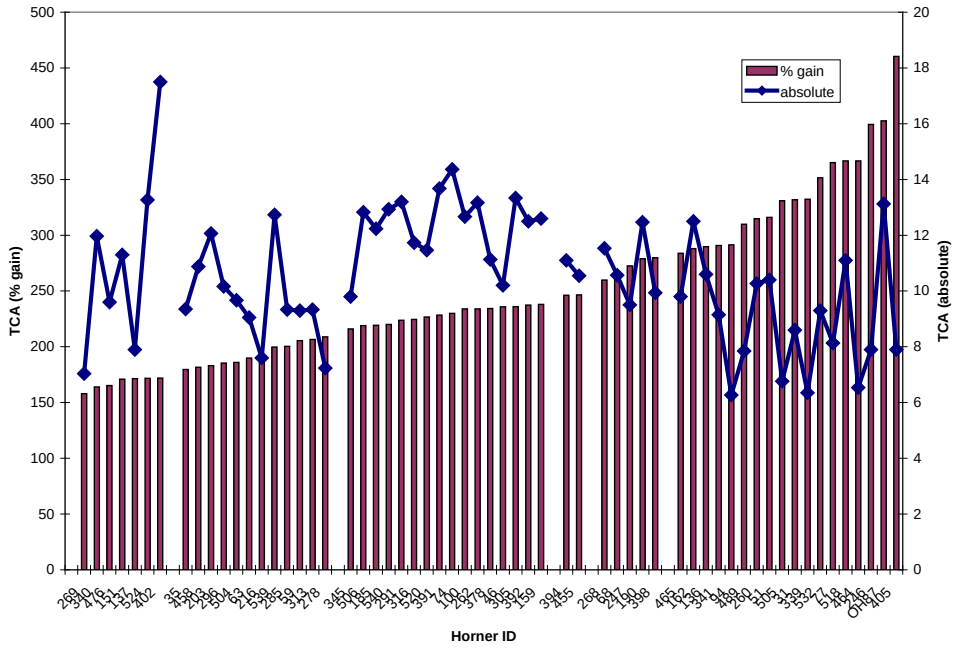

Figure 3. Range of tree size and growth across all selections (65) in Horner 2006 planting. Relative trunk cross-sectional area (TCA) as either % gain (from planting though Fall 2008) or in absolute terms (TCA as of Fall 2008, recorded in cm^2).

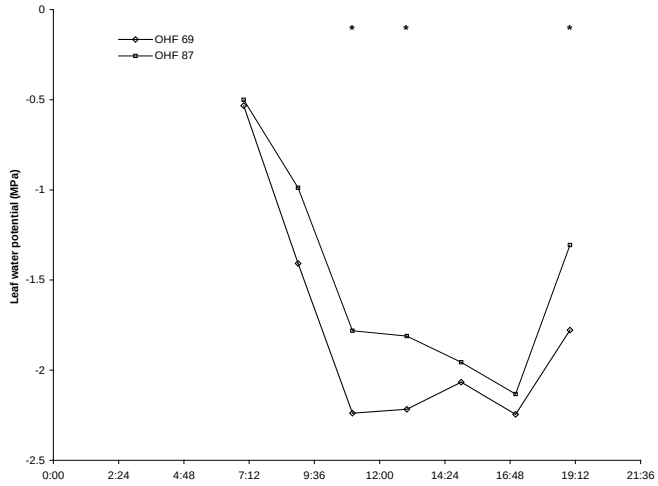

Figure 4. Typical diurnal trend of water potential values recorded on 14-August, 2008 for 'Bartlett' on either OHF 69 or 87. Trees had only received ~ 50 gallons of total irrigation following spring rain events. Asterisks at top indicate significance at $P < 0.05$. Each point is the mean of 9 leaves.

Tables

Table 1. Extrapolated yield for Horner 2004 - 5th leaf harvest.

Per acre extrapolated yield for Horner 2004 block-Harvest 2008[#]							
Horner Rootstock ID	Trees/acre 10x16 spacing	lbs./fruit per acre	44lb.Box/acre 80% packed	2006-08 Yield (lbs)	Box Sz	TCSA cm2	YE lbs fruit/cm2
21	272	245	4	0.9	100	17.2	0.05
21	272	2094	38	7.7	90	24	0.32
38	272	190	3	0.7	120	27.6	0.03
38	272	1877	34	6.9	100	23.2	0.30
45	272	707	13	2.6	100	24.1	0.11
45	272	1224	22	4.5	110	23.1	0.19
119	272	789	14	2.9	110	23.5	0.12
119	272	571	10	2.1	100	25.9	0.08
251	272	789	14	2.9	120	27.7	0.10
251	272	2258	41	8.3	80	19.4	0.43
334	272	1115	20	4.1	100	21.8	0.19
334	272	1360	25	5.0	100	23.2	0.22

[#]data are selections whose replicates have > 10 fruit per tree

Table 2. Extrapolated yield for Horner 2005 - 4th leaf harvest.

Per acre extrapolated yield for Horner 2005 block-Harvest 2008[#]							
Horner Rootstock ID	Trees/acre 10x16 spacing	lbs./fruit per acre	44lb.Box/acre 80% packed	2008 Yield (lbs)	Box Sz	TCSA cm^2	YE lbs fruit/cm^2
498	272	136	2	0.5	90	21.40	0.023
498	272	571	10	2.1	100	35.09	0.060
498	272	381	7	1.4	120	38.17	0.037
352	272	272	5	1	90	13.87	0.072
352	272	571	10	2.1	100	18.87	0.111
352	272	598	11	2.2	100	35.77	0.062

[#]data are selections whose replicates have > 5 fruit per tree

Table 3. Extrapolated yield for Horner 2006 - 3rd leaf harvest.

Per acre extrapolated yield for Horner 2006 block-Harvest 2008[#]							
Horner Rootstock ID	Trees/acre 10x16 spacing	lbs./fruit per acre	44lb.Box/acre 80% packed	2008 Yield (lbs)	Box Sz	TCSA cm^2	YE lbs fruit/cm^2
398	272	435	8	1.6	110	15.15	0.106
398	272	272	5	1.0	90	19.62	0.051

[#] Horner 398 was the only replicated clone that set fruit in 2008

Table 4. Cumulative extrapolated yield for Horner 2004 block, 2006-2008.

Per acre extrapolated yield for Horner 2004 block-Harvest 2006-2008							
Horner Rootstock ID	Trees/acre 10x16 spacing	lbs./fruit per acre	44lb.Box/acre 80% packed	2006-08 Yield (lbs)	Average Box Sz	TCSA cm^2	YE lbs fruit/cm^2
81	272	2584	47	9.5	90	45.84	0.207
81	272	3400	62	12.5	90	52.15	0.240
93	272	1798	33	6.6	110	42.46	0.156
93	272	2176	40	8.0	100	23.00	0.348
119	272	2339	43	8.6	90	23.5	0.366
119	272	1790	33	6.6	90	25.9	0.254
220	272	2258	41	8.3	90	46.60	0.178
220	272	3345	61	12.3	90	62.39	0.197
307	272	2040	37	7.5	110	64.64	0.116
307	272	2040	37	7.5	110	40.64	0.185
232B	272	1605	29	5.9	120	48.55	0.122
232B	272	2339	43	8.6	90	27.24	0.316

[#]data are selections whose replicates have > 15 fruit per tree

Table 5. Cumulative extrapolated yield for Horner 2005 block, 2006-2008[$]

Per acre extrapolated yield for Horner 2005 block-Harvest 2007							
Horner Rootstock ID	Trees/acre 10x16 spacing	lbs./fruit per acre	44lb.Box/acre 80% packed	2007 Yield (lbs)	Box Sz	TCSA cm^2	YE lbs fruit/cm^2
399	272	261	5	0.96	92	6.30	0.152
411	272	134	2	0.49	89	9.28	0.053
403	272	282	5	1.04	85	11.46	0.090
390	272	326	6	1.20	73	9.28	0.129
355	272	219	4	0.81	109	7.03	0.115

[$] data are taken from 2007 harvest (2008 fruit set explained below in Table 6)

Table 6. Horner 2005 flower clusters and fruit set in 2008.

2008 Flower clusters and fruit set for Horner 2005 block						
Horner 2005 ROW	TREE	H-ID#	Number of clusters	#fruit 06/08	Harvest 2008 #fruit	wt (lbs)
2	31	355	0			
8	12	355	9			
12	14	355	8			
2	7	390	2			
6	22	390	0			
10	20	390	29			
2	23	399	19			
8	8	399	6			
11	7	399	43			
1	3	411	98			
8	25	411	89	1	1	0.4
11	22	411	85			
3	20	403	147	8	8	2.8
8	3	403	104	1	1	0.5
10	6	403	29			