FINAL PROJECT REPORT **YEAR**: 3 of 3

Project Title: Horner rootstock grower evaluation trials

PI: Todd Einhorn
Organization: OSU-MCAREC
Telephone: (541) 386-2030 x13
Email: Todd.einhorn@oregonstate.edu
Address: 3005 Experiment Station Drive
City: Hood River
State/Zip: OR 97031

Co-PI (2): Tom Auvil
Organization: WTFRC
Telephone: 509-665-8271
Email: Auvil@treefruitresearch.com
Address: 1719 Springwater Drive
City: Wenatchee
State/Zip: WA 98801

CO-PI: Steve Castagnoli
Organization: OSU
Telephone: 541-386-3343
Email: Steve.castagnoli@oregonstate.edu
Address: 2990 Experiment Station Drive
City: Hood River
State/Zip: OR 97031

Cooperators: Growers: Mike McCarthy and Eric Von Lubken (Hood River Trial), Chuck Peters (Wapato Trial), Bob Foyle and site manager Garrett Znan, (Bridgeport Trial), Mark Stennes (Methow Trial).

Total Project Request: **Year 1:** $14,335 **Year 2:** $16,134 **Year 3:** $13,197

Other funding sources: None

Budget 1: Todd Einhorn
Organization Name: OSU-MCAREC **Contract Administrator:** L.J. Koong
Telephone: 541 737-4866 **Email address:** l.j.koong@oregonstate.edu

Item	2012	2013	2014
Salaries[1]	3,142	3,236	1,667
Benefits	2,168	2,233	1,150
Wages			
Benefits			
Equipment			
Supplies			
Travel[2]	500	1,300	650
Miscellaneous			
Total	$5,810	$6,769	$3,467

Footnotes: [1] **Salaries are calculated as 2 weeks of a Full Time Technician's salary and OPE, for oversight of field plots, plant measurements, and data management. The increase in salaries for years two and three reflects a 3 % rate increase.** [2] **Travel includes 1 trip to WA sites/year beginning in year 2 (2013) at 0.51 cents per mile, one night lodging and two days per diem for PI and technician, and visits to OR orchard sites for data collection and support.**

Budget 2: Tom Auvil
Organization Name: WA Tree Fruit Research Comm. **Contract Administrator:** Kathy Schmidt
Telephone: 509-665-8271 **Email address:** Kathy@treefruitresearch.com

Item	2012	2013	2014
Salaries[1]	3,000	3,500	3,600
Benefits[1]	1,050	1,225	1,260
Wages[1]	2,675	2,800	2,900
Benefits	800	840	870
Equipment			
Supplies			
Travel[1]	900	900	1,000
Miscellaneous	100	100	100
Total	$8,525	$9,365	$9,730

[1]Salary and benefits include WTFRC internal program's time for supervision, planning, logistics and data management for pear projects.

Objectives:

1. Determine the influence of Horner 4 and 10 on tree growth, flowering, fruit size, yield (both annual and cumulative) and quality for the cultivars, 'Bartlett', 'Golden Russet Bosc' and 'd'Anjou'. OH×F 87 will be used as the standard.

2. Compare rootstock/scion interactions among orchards at different geographic locations.

Significant Findings:

Cumulative

- After 6 years, OH×F 87 consistently ranked highest for yield and yield efficiency compared to Horner 10 and Horner 4 at four separate trials. In some cases, numerical differences were not significant. For a given tree density, the relatively high yield efficiency of OH×F 87 suggests that it is more effective allocating carbon to fruits relative to vegetative growth.
- Horner 4 yields were either similar to or slightly less than OH×F 87, with the exception of one Bartlett site where Horner 4 produced markedly lower yields than OH×F 87. Yield efficiency of Horner 4, however, was typically lower than OH×F 87, due to its higher vigor. Interestingly, precocity was not delayed by the invigorating effect of Horner 4. Generally, annual variations in fruit size obscured rootstock effects; however, Horner 4 typically had the largest fruit size.
- A general trend in tree size was Horner 4 ≥ OH×F 87 ≥ Horner 10. The largest differences were observed for 'd'Anjou', where trees were ~40% larger on Horner 4 than either OH×F 87 or Horner 10.
- In three of four trials, Horner 10 produced the lowest yields, poorest yield efficiency and smallest fruit size. For 'Bosc', yield efficiency on Horner 10 was intermediate, primarily due to the rootstock's significant reduction of Bosc tree size.
- Tree mortality varied across sites (for a range of reasons) but was unrelated to rootstock genotype.

2014

- 'Bartlett' trees at Wapato produced excellent yields in the sixth leaf for all rootstocks (projected per acre yields between 55-59 bins). Horner 10 yields (44 bins) were significantly less than OH×F 87. Tree size was only slightly larger on Horner 4. Fruit size was similar among rootstocks but on the smaller end (average box size between 100s and 110s).
- 'Bartlett' yields at Methow were nearly double for OH×F 87 trees (47 bins/acre) compared to the Horner rootstocks (~25 bins/acre). Fruit size was good (size 80s and 90s) on all rootstocks.
- 'GR Bosc' yields were ~ 20% to 30% lower than the previous year, presumably as a result of biennial bearing. Comparatively, rootstocks performed similarly in both years; OH×F 87 had higher yields than the Horner rootstocks. Trees on Horner 10 were ~25% smaller compared to other rootstocks.
- Sixth leaf 'd'Anjou' yields were excellent for trees on OH×F 87 and Horner 4 (~42 bins/acre). Although Horner 10 produced an equivalent number of fruit per tree as OH×F 87 and Horner 4, fruit size was markedly smaller (box size 135, compared to 100s), resulting in 30% less total yield (29 bins/acre)… of box size 135 fruit. Trees on Horner 4 were 55% larger than the other rootstocks.

Results and Discussion:

1. Sites

Wapato (Bartlett and Bosc) had roughly 40% of the planting affected by fire blight. Rootstock genotype did not relate to fire blight susceptibility (i.e., trees on all rootstocks were similarly affected). As indicated in the 2013 report, the Parkdale, OR 'd'Anjou' site was removed after the 2013 season based on a high incidence of fire blight and Pseudomonas infection. Despite severe fires surrounding the Methow (Bartlett) site, trees were largely unaffected. Averaged across sites, tree mortality remained at 2013 levels of 33%, 25% and 29% for OH×F 87, Horner 4 and Horner 10, respectively.

Details pertaining to the existing trial sites are provided below:

Hood River

- Spacing: 17' x 6' (427 trees per acre)
- Scion: 'd'Anjou'
- Rootstocks: OH×F 87, Horner 4, Horner 10
- System: Modified central leader/three wire support
- Replicates: Six, five-tree reps

Wapato

- Spacing: 10' x 4' (1089 trees per acre)
- Scion: 'Bartlett' and 'Bosc'
- Rootstocks: OH×F 87, Horner 4, Horner 10
- System: Tall spindle fruiting wall/wire support
- Replicates: Five, five-tree reps

Methow

- Spacing: 12' x 4' (907 trees per acre)
- Scion: 'Bartlett'
- Rootstocks: OH×F 87, Horner 4, Horner 10
- System: Tall spindle/wire support
- Replicates: Five, five-tree reps

For these trials, cultivar is confounded with site; therefore, overall performance comparison among rootstocks (i.e., averaged across sites) carries little value. While general trends in the measured parameters can be observed, unique habits of cultivars and/or cultivar:rootstock combinations can disproportionately alter the data. Therefore, rootstocks will only be compared 'within' individual cultivars.

2. Rootstock effects on Cultivars

D'Anjou'

Yields of 42 bins per acre in the 6th leaf are considered excellent for 'd'Anjou' (Table 1). These yields were achieved on OH×F 87 and Horner 4. Horner 10, in contrast, produced 30% less yield despite setting a similar number of fruits per tree (~250 fruits per tree). The yield reduction was attributed to fruit size; 'D'Anjou' pears on Horner 10 peaked on box size 135. Tree size on Horner 10 was no different than tree size on OH×F 87 underscoring the direct rootstock effect on fruit size. In Hood River, trees on Horner 4 were 55% larger than trees on Horner 10 or OH×F 87. This was an

effect observed in preliminary trials with Horner 4 (all performed with ‘d’Anjou’ as the cultivar) and can be seen in the mother block (Horner 4 is in the upper 5% for tree size in a population of over 450 individuals). Interestingly, the magnitude of vigor induced by Horner 4 compared to other rootstocks varies with the scion and, to a lesser degree, site. Horner 4 may offer distinct advantages over alternative rootstocks of comparable vigor in low-fertility soils, lower density configurations, or as replacement trees in established blocks. An evaluation of Horner 4 in replant sites might also prove useful. Trees on Horner 4 have filled their in-row space of 6 ft., but given their high bearing potential (fruit buds look good for 2015) the grower is comfortable managing the trees. In contrast to this planting, Horner 4 did not perform so well in a recently concluded 10-year evaluation of ‘d’Anjou’ performance on ten promising pear rootstocks. Horner 4 ranked 5th in yield, 9th in yield efficiency and 1st in trunk size. OH×F 87 was the best performing rootstock in that trial for yield and yield efficiency, despite ranking 7th in tree size.

Table 1. Horner Rootstock On-Farm Trials. 2014 and cumulative (through 6th leaf) production at four sites in the PNW: 'd'Anjou', Hood River, OR; Bartlett, Methow, WA; Bartlett; Wapato, WA; Bosc, Wapato, WA.

	2014 #				Cumulative		
d'Anjou	TCA (cm^2)	Yield (lbs/tree)	Fruit wt. (g)	Proj. production (bins/a)	Yield (lbs/tree)	Yield effic. (kg/cm^2 TCA)	Fruit wt. (g)
OH×F87	57.5 b	107.2 a	185 a	41.5 a	139.2 a	1.1 a	214 ab
Horner 4	87.2 a	110.5 a	204 a	42.4 a	139 a	0.72 b	225 a
Horner 10	55.4 b	78.7 b	150 b	28.7 b	99.7 b	0.79 b	200 b

#6th leaf production; 427 trees/acre

	2014 #				Cumulative		
Bartlett	TCA (cm^2)	Yield (lbs/tree)	Fruit wt. (g)	Proj. production (bins/a)	Yield (lbs/tree)	Yield effic. (kg/cm^2 TCA)	Fruit wt. (g)
OH×F87	32.7	56.8 a	232	46.6 a	114.3 a	1.62 a	202 b
Horner 4	33.4	28.3 b	253	23.3 b	79.8 b	1.1 b	228 a
Horner 10	29.6	32.9 b	228	27.3 b	77.6 b	1.17 b	197 b

#6th leaf production; 908 trees/acre

	2014 #				Cumulative		
Bartlett	TCA (cm^2)	Yield (lbs/tree)	Fruit wt. (g)	Proj. production (bins/a)	Yield (lbs/tree)	Yield effic. (kg/cm^2 TCA)	Fruit wt. (g)
OH×F87	30.2 ab	58.1	194	57.3	150.9 a	2.26 a	191
Horner 4	33.1 a	59.9	190	59.1	140.3 ab	1.93 ab	195
Horner 10	28.2 b	55.3	195	54.4	116.5 b	1.78 b	191

#6th leaf production; 1,089 trees/acre

	2014 #				Cumulative		
Bosc	TCA (cm^2)	Yield (lbs/tree)	Fruit wt. (g)	Proj. production (bins/a)	Yield (lbs/tree)	Yield effic. (kg/cm^2 TCA)	Fruit wt. (g)
OH×F87	42 a	30.9	247	30.4	70.9	1.01 a	245
Horner 4	46.3 a	22.3	246	22	67.4	0.66 b	257
Horner 10	33.1 b	23.9	230	23.6	57.2	0.84 ab	242

#6th leaf production; 1,089 trees/acre

Data- 6 reps for 'd'Anjou. All other sites 5 reps (5 contiguous trees/rep).

‘Golden Russet Bosc’

‘Bosc’ trees attained good 5th leaf yields in 2013 with excellent fruit size (70s). Yields were reduced in 2014, however, by ~20%. This reduction in yield was attributed to both biennial bearing and corrective pruning of fire-blight infected wood (reducing bearing volume). Rootstocks did not affect this biennial swing in bearing. OH×F 87 produced the highest yields in 2013 (significantly) and 2014 (nonsignificantly). In 2014, Horner 4 and Horner 10 produced similar tree yields, but fruits were larger on Horner 4 (Table 1). Fruit size was excellent, however, for all rootstocks. Tree size was positively influenced by Horner 10; producing trees ~25% smaller than the other rootstocks. In fact, this was the only trial where Horner 10 produced significantly smaller trees than OH×F 87. Despite the dwarfing conferred by Horner 10, yield efficiency, over the entire project, was highest for OH×F 87 (Table 1).

‘Bartlett’.

Two sites were trialed with fairly similar outcomes with respect to yield and yield efficiency (Table 1). OH×F 87 performed best, but Horner 4 was similar at one trial (Wapato). In Wapato, ‘Bartlett’ production exceeded 50 bins per acre for the third consecutive year (~58 bins per acre for Horner 4 and OH×F 87 in 2014). Fruit size was on the low end of box size 100. Tree size was largest on Horner 4 but differences among rootstocks were not large (~15% difference between the largest and smallest trees). The cumulative yield efficiency of OH×F 87 through the 6th leaf (2.26 kg/cm^2 TCA) is roughly two-fold that achieved in comparable rootstock evaluation trials in the US (Elkins et al., 2011). Consistent high production was associated with good fertigation and irrigation practices. Horner 10 yields were high in 2014 despite being consistently low in the previous years. Overall, however, Horner 10 had significantly lower yields and yield efficiency compared to OH×F 87 despite similar tree size (Table 1).

At Methow, OH×F 87 produced significantly higher Bartlett yields than either of the Horner rootstocks (Table 1). Fruit size on Horner 4 was usually a box size larger than OH×F 87 each year, but at a cost of 30% less yield over the duration of the project (Table 1). Despite having lower yields and yield efficiency, Horner 10 had the smallest fruit size.

Executive Summary
Five trial sites were established in 2009 to test effects of Horner 4 and Horner 10 rootstocks on performance of 'GR-Bosc', 'd'Anjou', and 'Bartlett'. OHxF 87 was included as the control at each site. Trial sites were established as high-density plantings in commercial orchards. Cultivar selection, planting design and training system varied from site to site. Trees were well-managed at all sites.

After 6 years, OH×F 87 consistently ranked highest for yield and yield efficiency compared to Horner 10 and Horner 4 at four separate trials. In some cases, numerical differences were not significant. For a given tree density, the relatively high yield efficiency of OH×F 87 suggests that it is more effective allocating carbon to fruits relative to vegetative growth.

Horner 4 yields were either similar to or slightly less than OH×F 87, with the exception of one Bartlett site where Horner 4 produced markedly lower yields than OH×F 87. Yield efficiency of Horner 4, however, was typically lower than OH×F 87, due to its relatively higher vigor. Interestingly, precocity was not delayed by the invigorating effect of Horner 4. Generally, annual variations in fruit size obscured rootstock effects; however, Horner 4 typically had the largest fruit size.

A general trend in tree size was Horner 4 ≥ OH×F 87 ≥ Horner 10. The largest differences were observed for 'd'Anjou'; trees were ~40% larger on Horner 4 than either OH×F 87 or Horner 10. Given Horner 4's effect on tree size, we would not recommend the combination 'd'Anjou'/Horner 4 in high-density plantings. However, on difficult, weak sites, lower density configurations, or as replacement trees in established blocks, Horner 4 may have distinct advantages over comparably vigorous rootstocks.

In three of four trials, Horner 10 produced the lowest yields, poorest yield efficiency and smallest fruit size. We do not recommend continued trialing of Horner 10.

Given the high productivity of all sites, trees appear well balanced and manageable in their high-density configurations through 6th leaf production.