

FINAL PROJECT REPORT**YEAR:** 3 of 3**Project Title:** Horner rootstock grower evaluation trials

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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).

¹Budget: **Year 1:** \$15,370 **Year 2:** \$16,958 **Year 3:** \$18,552

Other funding sources: None

Budget 1: Todd Einhorn

Organization Name: OSU-MCAREC
Telephone: 541 737-3228

Contract Administrator: Cynthia Cox
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Item	2009	2010	2011
Salaries ¹	2,905	3,021	3,142
Benefits	1,765	1,837	1,910
Wages			
Benefits			
Equipment			
Supplies			
Travel ²	1,500	1,500	1,500
Miscellaneous			
Total	\$6,170	\$6,358	\$6,552

Footnotes: ¹ Salaries are calculated as 2 weeks of a Full Time Technician's salary and OPE, for oversight of planting, mapping, plant measurements, and data management. The increase in salaries for years two and three reflects a 4 % rate increase. ² Travel includes 1 trip to WA sites/year at 0.58 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

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Item	2009	2010	2011
Salaries¹	4200	5280	6,000
Benefits¹	1330	1672	1,900
Wages¹	1475	2024	2,300
Benefits	425	624	700
Equipment			
Supplies			
Travel¹	900	900	1000
Miscellaneous	800	100	100
Total	\$9200	\$10,600	\$12,000

¹Salary 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, yield, fruit size and quality for the cultivars, 'Bartlett', 'Golden Russet Bosc' and 'd'Anjou'. OHxF 87 will be used as the standard.
2. Compare rootstock/scion interactions among orchards at different geographic locations.

Significant Findings 2009-2011:

- Of the five trial sites planted, four are performing well. A fifth site was inadvertently subjected to herbicide damage in 2010. Trunk circumference is roughly 25-50% of that observed at other sites.
- The mortality rate for all sites was 6 %, but varied markedly among sites (e.g., range of 1% to 12%). Averaging across scion cultivars and sites, Horner 4 sustained the greatest rootstock mortality rate [10%], Horner 10 was intermediate [7%], and OHxF 87 had the fewest losses [3%] (Table 1). Causes of individual tree losses varied with site, and do not appear to be related to rootstock genotype.
- Third leaf 'Bartlett' bloom was slightly lower on Horner 10 than either Horner 4 or OHxF 87; however, Horner 10 fruit set was reduced by ~40%.
- First crop 'Bartlett' fruit size was small, irrespective of rootstock.
- Precocity of 'GR Bosc' and 'Anjou' was not observed through third leaf for any rootstock/cultivar combination.
- At the completion of 3rd leaf, 'Bosc' tree size was slightly smaller on Horner 10 than either Horner 4 or OHxF 87, which were roughly equivalent.
- At both 'Bartlett' sites, tree size was slightly, and non-significantly, smaller on Horner 10 than either OHxF 87 or Horner 4, which were roughly equivalent in size.
- For 'd'Anjou', OHxF 87 and Horner 10 produced trees similar in size, and ~ 40 % smaller than trees on Horner 4, not including data from the Bridgeport site.
- Root suckering was not observed.

Results and Discussion:

1. Sites.

Fumigated trial sites were planted spring 2009. All trees were headed and feathers removed at the time of planting. Planting methods included: 1) Shovel-planted (all WA sites), 2) Augured holes (Hood River), and 3) Tractor-drawn transplanter (Parkdale). Grower cooperators, researchers and technicians continued to collaborate on training system and plot management decisions. Information pertaining to individual sites is provided below:

Hood River

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

Parkdale

- Spacing: 12' x 6' (605 trees/acre)
- Scion: 'd'Anjou'
- Rootstocks: OH x F 87, Horner 4, Horner 10
- System: In-line "V" fruiting wall/wire support

- Replicates: Six, five-tree reps

Bridgeport Anjou

- Spacing: 16' x 6' (OHxF87 and Horner 10), 16' x 8' (Horner 4)
- Scion: 'd'Anjou'
- Rootstocks: OH x F 87, Horner 4, Horner 10
- System: Perpendicular "V"/wire support
- Replicates: Five, five-tree reps

Bridgeport Bosc

- Spacing: 16' x 5' for OHxF 87 and Horner 10; 545 trees per acre), 16' x 7' (Horner 4; 389 trees per acre)
- Scion: 'Bosc'
- Rootstocks: OH x F 87, Horner 4, Horner 10
- System: Perpendicular "V"/wire support
- Replicates: Five, five-tree reps

Wapato

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

2. Rootstock effects

Effects of rootstocks are presented relative to cultivar.

- A. 'd'Anjou'. Horner 4 produced a markedly larger tree than either Horner 10 or OHxF 87, at both Oregon sites (Table 1). Limited bloom and fruit set, and insignificant yields were observed at Parkdale (Table 2). Trees at both sites were vigorous, and precocity was not induced by any of the rootstocks evaluated. Bridgeport was initially characterized as a low vigor site due to poor soil fertility and the presence of gravel bars throughout the profile. There is value for including low-vigor sites in the trial, since preliminary data (Meilke and Sugar, 2004) indicated a substantial difference in vigor between the two 'Horner' rootstocks. Subsequently, a potentially vigorous rootstock, such as Horner 4, might result in superior performance under poor fertility conditions. However, herbicide-induced phyto-toxicity confounded results at the Bridgeport site. Interestingly, the inherent vigor of Horner 4 was observable at Bridgeport, despite herbicide damage (Table 1). Fruit set between the 4th and 7th leaf will be critical for management of Anjou in higher-density plantings.

Anjou mortality rates were high at the Hood River site (11%) following the 2010 season. Tree losses were highest for OHxF 87 and Horner 4; incidentally, tree size was significantly smaller for both of these roots relative to those on Horner 4 at the end of year one. It is likely that these ‘weaker’ trees succumbed to a combination of environmental factors and disease pressure. However, no additional trees losses were recorded in 2011 (Table 5), and the general health of the planting is good. Notably, similar tree losses were not observed at the two other ‘d’Anjou’ sites, indicating that site specific issues were likely responsible for the higher mortality rates of Horner 10.

Table 1. 2011 trunk size [trunk cross-sectional area (cm²)] and yield efficiency [kg of yield/cm² TCA] per rootstock-cultivar combination for all sites.

Rootstock	Cultivar	Site	Trunk Size	Yield Efficiency
			TCA(cm ²)	Yield/TCA (kg/cm ²)
Horner 10	Bartlett	Wapato	9.5	0.7
		Methow	10.9	0.1
Horner 4		Wapato	11.2	0.8
		Methow	12.1	0.1
OHxF87		Wapato	10.9	0.9
		Methow	12.3	0.3
Horner 10	GR Bosc	Wapato	11.6	0.2
		Bridgeport	7.7	n.d.
Horner 4		Wapato	13.3	0.1
		Bridgeport	6.8	n.d.
OHxF87		Wapato	13.2	0.2
		Bridgeport	7	n.d.
Horner 10	Anjou	Bridgeport	5.2	n.d.
		Hood River	17.5	n.d.
		Parkdale	19.8	n.d.
Horner 4		Bridgeport	6.6	n.d.
		Hood River	27.2	n.d.
		Parkdale	27.1	n.d.
OHxF87		Bridgeport	5.1	n.d.
		Hood River	16.9	n.d.
		Parkdale	18.3	n.d.

n.d., no data due to insignificant yield.

Table 2. 2011 ‘Anjou’ flowering (total clusters per tree), total fruit per tree, and fruit set (per 100 clusters) as affected by rootstock.

Rootstock	Site	Avg. Clusters (no./tree)	Avg. Fruit (no. at set/tree)	Fruit set (% [fruit/cluster])
Horner 10	Parkdale	9	0.4	4.4
	Bridgeport	n/a	n/a	n/a
	Hood River	n/a	n/a	n/a
Horner 4	Parkdale	17	1.7	10
	Bridgeport	n/a	n/a	n/a
	Hood River	n/a	n/a	n/a
OHxF87	Parkdale	7	0.4	5.7
	Bridgeport	n/a	n/a	n/a
	Hood River	n/a	n/a	n/a
		n.s.	n.s.	n.s.

²n/a (data not available)

B. ‘GR-Bosc’. Interestingly, for ‘GR Bosc’, Horner 4 did not impart significantly greater vigor in the tree (Table 1), compared to the other rootstocks. Only slight differences in tree size were observed between Horner 10 (smaller), and the slightly larger OHxF 87 and Horner 4 (Table 1). Similarly to ‘d’Anjou’, the Bridgeport trees suffered from the combination of a low vigor site, and herbicide damage, consequently trees were much smaller at Bridgeport. Although ‘GR Bosc’ is more precocious than Anjou, significant flowering and fruit set were not observed (Table 3), regardless of rootstock. It is plausible that the 4’ spacing between trees at Wapato might result in enhanced root competition between adjacent trees, but perhaps additional years will be required to observe such effects.

Table 3. 2011 ‘GR Bosc’ flowering (total clusters per tree), total fruit per tree, fruit set (per 100 clusters), yield (lbs) and fruit size (g) as affected by rootstock.

Rootstock	Site	Avg. Clusters (no./tree)	Avg. Fruit (no. at set/tree)	Fruit per 100 clusters	Yield (lbs)	Fruit (no. at harvest)	Fruit Size ¹ (g)
Horner 10	Wapato	28	10	39	4.3	10	197
	Bridgeport	n/a	n/a	n/a	n/a	n/a	n/a
Horner 4	Wapato	7	7	118	3	7	185
	Bridgeport	n/a	n/a	n/a	n/a	n/a	n/a
OHxF87	Wapato	18	10	103	5	10	218
	Bridgeport	n/a	n/a	n/a	n/a	n/a	n/a
		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

¹Fruit size taken on all fruit (including undersized culls).

²n/a (data not available)

C. ‘Bartlett’. At both ‘Bartlett’ sites tree size was smallest, albeit non-significantly, for Horner 10 (Table 1). As observed for ‘GR Bosc’, Horner 4 tree size was equal to OHxF 87. The inherent precocity of ‘Bartlett’, relative to the other cultivars, was observed at both sites, though markedly more pronounced at Wapato (Table 4). Significant differences were observed in the number of fruit set at Wapato; Horner 10 had roughly 30% fewer fruit than either Horner 4 or OHxF 87, and nearly half the yield (Table 4). It appears that earlier canopy development, and subsequently greater canopy volume of Horner 4 and OHxF 87 resulted in higher productivity. Alternatively, relative fruit set data (fruit per 100 clusters)

imply that the more dwarfing Horner 10 did not enhance precocity. Fruit size was small (Table 4), as is often observed in first-year crops; however, fruit size was determined as the average of the total number of fruit, including non-marketable fruit, and therefore is not entirely representative of the crop. Future efforts will need to present size-class, distribution data, so rootstocks comparisons can be made using proportions of marketable and non-marketable fruit.

Table 4. 2011 ‘Bartlett’ flowering (total clusters per tree), total fruit per tree, fruit set (per 100 clusters), yield (lbs) and fruit size (g) as affected by rootstock.

Rootstock	Site	Avg. Clusters (no./tree)	Avg. Fruit (no. at set/tree)	Fruit per 100 clusters	Yield (lbs)	Fruit (no. at harvest)	Fruit Size ¹ (g)
Horner 10	Wapato	124	38 b ²	36	13.9 B ³	38.3 B	165
	Methow	40	6	19	2.3 b	6.5 b	161
Horner 4	Wapato	146	60 a	47	20.2 A	60.2 A	152
	Methow	67	8	11	3.1 b	8.1 b	176
OHxF87	Wapato	124	62 a	41	21.9 A	61 A	163
	Methow	63	17	29	7.4 a	16.9 a	176
		n.s.		n.s.			n.s.

¹Fruit size is the average for all fruit (including undersized culls)

²Capital letters indicate significant differences at Wapato site within columns

³Lower-case letters indicate significant differences at Methow site within columns

Table 5. Mortality rates of rootstock clones. Data are cumulative through 2011.

Rootstock	Individual Tree Losses	Total trees planted	Mortality rate %
Horner 4	18	185	10
Horner 10	13	185	7
OH x F 87	5	185	3

Executive Summary

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

In the third leaf (2011) only 'Bartlett' trees flowered and set a significant crop. Differences existed between the two 'Bartlett' sites. At Wapato, WA, Horner 4 and OHxF 87 had similar and higher fruit set, and yields than Horner 10. At Methow, WA, OHxF 87 had the highest yield, but first crop production was quite low for all rootstocks at this site. None of the rootstocks induced precocity in 'GR-Bosc' or 'd'Anjou', at any site.

Tree size was not significantly influenced by rootstock for either 'Bartlett' or 'GR-Bosc', though trees were slightly larger on Horner 4. In 'd'Anjou', Horner 4 produced a significantly larger tree than Horner 10 and OHxF 87, at two of the three 'd'Anjou' sites. Tree size of 'd'Anjou' on Horner 10 and OHxF 87 were similar. A third site was still recovering from inadvertent herbicide-induced phytotoxicity.

Mortality rates were low at all sites (ranging from 3%-10%), and did not appear to be related to rootstock genotype. Suckering was not observed in any of the combinations.