

## **Evaluation of Potential New, Size Controlling Rootstocks for European Pears**

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### **ABSTRACT**

The Multi-state Research Project NC140, "Improving Economic and Environmental Sustainability in Tree Fruit Production Through Changes in Rootstock Use", was established in the late 1980s. The first multi-state pear trial was established in 1987 and subsequent ones in 2004-2006. Three trials were planted in California in April 2005: Bartlett in Mendocino (loam) and Sacramento (clay) Counties and Golden Russet Bosc in Mendocino County (loam). Trial design in California is the standard NC-140 configuration of randomized complete block (RCB) with 10 single tree replicates. Rootstocks include 708-36 (UK), BM2000 (Australia), Fox 11 (Italy), Horner 4, OHxF69 (Mendocino only), and OHxF87 (Oregon), Pyro-233 and Pyrodwarf (Germany), and Winter Nelis as a standard (Sacramento County only). Survival rate in both locations is generally good, ranging from 60-100%, with Fox 11 having the most losses. For Bartletts, 2009 flower clusters and yields were 78 and 66% higher, respectively, in Mendocino County, although trunk circumference (TCSA) was 58% greater in Sacramento. This resulted in 75% greater yield efficiency in Mendocino, possibly due to water stress in the Sacramento trial. Horner-4 yielded the most and 708-36 and Pyro 2-33 the least in Mendocino, with no differences in yield efficiency. In Sacramento, Fox-11 yielded the most and BM-2000 the least, and yield efficiency was best for Pyro 2-33. For Bosc (Mendocino only), OHxF87 had the most flower clusters and yield and best yield efficiency, and BM2000 and Fox 11 the fewest flowers, least yield, and worst yield efficiency. 2009 was the fifth season of the 10 year trial. Data will be collected in 2010 (Mendocino trials only) and a 5-year report (2005-2009) covering California, Washington, New York, Nova Scotia, Canada and Chihuahua, Mexico will be completed.

### **INTRODUCTION**

There are very few commercially viable size controlling rootstocks for pears. Quince rootstock is widely used in Europe, but has only been successfully used as a rootstock for Comice in the U.S. The Old Home x Farmingdale (Brooks®) series offers several potential options that have only recently been explored. The two OHxF selections most offered by major wholesale nurseries are 97 and 87 (333 is generally sold to homeowners). 97 is a large tree (though more precocious than *P. betulaefolia*), similar to Winter Nelis. 87 is a smaller tree, but has been shown to produce small fruit in some locations. Data from California, and more recently Washington, has suggested that a very promising OHxF selection appears to be 69, which has yet to become widely commercially available (Elkins and DeJong, 2002, Elkins et al., 2008).

The NC140 Regional Rootstock Research Project ([www.NC140.org](http://www.NC140.org)) is a federally-supported, multi-state project for perennial fruit and nut crops. The goal is to disseminate information generated from trials throughout the U.S. Each participating state establishes and evaluates similar ("uniform") trials using the same rootstocks and similar plot design so that regional differences can be determined. Progress and results are shared at an annual 2-day meeting and via the NC140 website. Each state submits an annual report which is distributed at the meeting. State reports are then compiled into a national report for USDA. California has long participated in NC140 for apples and peaches and began participating actively in pears in 2006.

In coordination with Oregon, Washington, and New York, three new NC140 trials were established in California in spring 2005, two in Talmage, Mendocino County (Bartlett and Golden Russet Bosc, 5' x 10' spacing), and one in Courtland (9' x 15' spacing). Trees were grown by Fowler Nurseries, Inc. in Newcastle. These trials are currently the **only replicated** rootstock trials in California and the Talmage Bartlett trial is the only one planted in 2005 that includes OHxF69. The information they provide will be invaluable for decisions, particularly for new, high density planting systems (the Talmage trial is planted at 871 trees per acre and is on very fertile soil).

### **Objectives in 2008 and 2009 included:**

- 1) Evaluate potential precocious, size-controlling rootstocks for pear orchards in California.
- 2) Evaluate rootstocks for size, vigor, growth habit on various soils, productivity, compatibility with major varieties, susceptibility to diseases and pests, propensity to sucker, etc.
- 3) Select the best potential candidates for future increased propagation and industry use.

### **MATERIALS AND METHODS**

Three trials were planted in northern California in April 2005. Design was Randomized Complete Block, with 10 single tree replicates per rootstock. Trials were also established in the Northwest in 2005 and 2006. Rootstock and cultivar selections varied by site, depending on availability and investigator preference (Table 1).

Data collection and calculation at each site from 2005-2009 varied slightly, but included trunk cross sectional area (TCSA), tree height, number of flower clusters, number of fruit, yield, yield efficiency, number of root suckers, and % survival.

### **RESULTS AND 2010 PLANS**

#### **2005 Bartlett Pear Rootstock Planting**

- 1) North Coast - Talmage, Mendocino County, Cole loam (Tables 2-3)

No trees died in 2009. Flowering increased by 165%, fruiting by 382%, and; tree yield by 323% compared to 2008 (Elkins and Ingels, 2008). Fruit size decreased by 7% and fruit was generally small (less than 200 grams), likely due to several hot spells through the growing season which impeded fruit growth statewide. There were no differences in cluster numbers, however, Horner 4 had the most and largest fruit, the largest TCSA, and the highest yield, nearly twice the average of all the other rootstocks, however, yield efficiency for all cultivars was equal.

- 2) Sacramento Delta - Courtland, Yolo County; Sacramento Basin clay soil (Table 4)

No trees died in 2009. Flowering increased 33% and fruit size by 34% compared to 2008. Fruit size was 10% larger than in Mendocino County, which is likely explained by poor yields, which averaged 66% less. There were no differences in number of flower clusters, fruit number, or fruit size. Fox 11 yielded the most and BM2000 the least.

## 2005 Golden Russet Bosc Pear Rootstock Planting

1) North Coast-Talmage, Mendocino County; Pinole-Yokayo-Redvine sandy loam (Tables 5-6)

No trees died in 2009. Flower clusters increased by 100% and number of fruit by 90% versus 2008. Fruit size was 26% larger and yield 34% higher compared to 2008, BM 2000 had the largest fruit (221 grams) while Pyro 2-33 had the smallest (183 grams). OHxF 87 had the most flowers and fruit and highest yield and yield efficiency, and Fox 11 and BM2000 the least.

**WORK PLANNED FOR 2010** - Data collection and rootstock evaluation will continue only in the two Mendocino County trials in 2010. Procedures will again follow guidelines established by the NC140 Technical Committee. The 5-year report (see above) will be presented at the ISHS International Pear Symposium in Argentina in November 2010.

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Table 1: Locations and included rootstocks, NC140 pear rootstock trials, Oregon and Washington, 2005 and 2006 plantings.

Rootstock	Origin	2005	2005	2005	2005	2006	2006	2006	2006
		MCAREC <sup>1</sup> Anjou	Cashmere Anjou	Tonasket Bosc	Yakima Bartlett	MCAREC Anjou	Cashmere Anjou	Tonasket Bosc	Yakima Bartlett
28-119	France	x							
Pyriam (OH-11)	France					x	x	x	x
P-2532	France					x	x	x	x
Bet 2291	China					x	x	x	x
BM 2000	Australia	x	x	x	x				
BU-2	Germany	x	x						
BU-3	Germany		x						
Fox 11	Italy Hood	x	x		x	x	x	x	
Horner 4	River, OR	x	x	x	x	x	x	x	x
OHxF 69	Oregon								x
OHxF 87	Oregon	x	x	x	x	x	x	x	x
Pyro 2-33	Germany	x		x					
Pyrodwarf	Germany	x	x	x	x				

<sup>1</sup> Mid-Columbia Agricultural Research and Extension Center, Hood River, Oregon

Table 2: Effects of 2005 NC-140 rootstock planting on tree growth, flower clusters, root suckers, and tree survival of 3-year-old (4th leaf) Bartlett pear trees, Talmage, California, 2008.

	Flower Clusters 4/8/08 (no./tree)	No. Fruit 8/22/08	Fruit Size 8/22/08 (g/fruit)	Yield 8/22/08 (kg/tree)	TCSA 12/14/08 (cm <sup>2</sup> )	Yield Efficiency 12/14/08 (kg/cm <sup>2</sup> )	Tree Height 2/14/08 (cm)	Root Suckers 10/03/07 (no./tree)	Tree Survival 10/03/07 (%/10 trees)
<b>ROOTSTOCK<sup>1</sup></b>									
708-36	5.6 ab	8.5 a	168	1.40 abc	12.6 bc	0.14 b	224 b	0.0	90
BM 2000	1.1 b	1.6 b	109	0.98 c	9.9 c	0.09 b	260 b	0.1	100
Horner-4	6.9 a	6.6 ab	194	3.11 a	18.9 a	0.16 ab	298 a	0.0	100
Fox 11	3.6 ab	5.5 ab	197	1.28 bc	10.6 b	0.12 b	243 b	0.0	80
OHxF 69	7.4 a	6.2 ab	192	1.61 c	14.5 b	0.09 b	230 b	0.1	100
OHxF 87	6.1 ab	8.1 a	172	3.03 ab	11.6 bc	0.26 a	230 b	0.0	100
Pyrodwarf	5.9 ab	6.0 ab	175	2.02 abc	11.4 bc	0.18 ab	221 b	0.0	90
Pyro 2-33	2.1 ab	3.5 ab	189	1.48 abc	10.5 bc	0.12 ab	219 b	0.0	70
<b>ANOVA<sup>2</sup></b>									
Rootstock	**	**	NS	**	***	***	***	NS	
Block	NS	NS	*	*	NS	*	NS	NS	

<sup>1</sup> Within columns, rootstock treatment means significantly different (Tukey HSD test,  $P \leq 0.05$ ).

<sup>2</sup> \*, \*\*, \*\*\* Indicate significance at  $P \leq 0.05$ , 0.01, and 0.001 respectively. NS indicates not significant  $P > 0.05$ .

Table 3: Effects of 2005 NC-140 rootstock planting on tree growth, flower clusters, number of fruit, root suckers, and tree survival among 4-year-old (5th leaf) Bartlett pear trees, Talmage, California, 2009.

	Flower Clusters 4/22/09 (no./tree)	No. Fruit 9/20/09	Fruit Size 8/20/09 (g/fruit)	Yield 8/20/09 (kg/tree)	TCSA 11/12/09 (cm <sup>2</sup> )	Yield Efficiency (kg/cm <sup>2</sup> )	Tree Height 11/12/09 (cm)	Root Suckers 11/12/09 (no./tree)	Tree Survival 11/12/09 (%/10 trees)
<b>ROOTSTOCK</b> <sup>1</sup>									
708-36	104.4	47.6 ab	144 b	7.72 b	14.04 c	0.42	239.3 bc	0.00	90
BM 2000	110.1	30.4 b	174 ab	5.28 b	17.56 bc	0.29	265.4 ab	0.20	100
Horner-4	142.5	73.7 a	187 a	13.76 a	33.96 a	0.40	289.2 a	0.00	100
Fox 11	90.0	44.0 b	164 ab	7.20 b	17.61 bc	0.34	252.8 bc	0.20	80
OHxF 69	158.3	47.9 ab	154 b	7.39 b	20.38 b	0.30	233.4 bc	0.00	100
OHxF 87	141.9	54.1 ab	154 b	8.34 b	16.89 bc	0.50	238.4 bc	0.00	100
Pyrodwarf	119.7	45.6 ab	155 b	7.08 b	16.48 bc	0.35	245.5 bc	0.00	90
Pyro 2-33	136.1	37.7 b	167 ab	6.28 b	13.57 c	0.28	225.1 c	0.10	70
<b>ANOVA</b> <sup>2</sup>									
Rootstock	NS	**	**	***	***	NS	***	NS	NS
Block	NS	*	NS	*	NS	NS	NS	NS	NS

<sup>1</sup> Within columns, rootstock treatment means significantly different (Tukey HSD test,  $P \leq 0.05$ ).

<sup>2</sup> \*, \*\*, \*\*\* Indicate significance at  $P \leq 0.05$ , 0.01, and 0.001 respectively. NS indicates not significant  $P > 0.05$ .

Table 4: NC-140 rootstock effects on tree growth, suckering, and harvest of 4-year-old (5th leaf) Bartlett pear trees, Courtland, California, 2009.

	Flower Clusters 3/25/09 (no./tree)	No. Fruit 7/24/09	Fruit Size 7/24/09 (g/fruit)	Yield 7/24/09 (kg/tree)	TCSA 10/27/09 (cm <sup>2</sup> )	Yield Efficiency (fruit/cm <sup>2</sup> )	Tree Height 10/27/09 (cm)	Root Suckers 10/27/09 (no./tree)	Tree Survival 10/27/09 (%/10 trees)
<b>ROOTSTOCK</b> <sup>1</sup>									
708-36	32.3	15.6	170	2.84 ab	19.01 d	0.75 a	261.3 d	0.29 d	70
BM 2000	18.0	5.4	112	1.01 b	36.37 ab	0.15 b	371.2 ab	7.14 a	70
Horner-4	22.9	10.6	187	2.11 ab	40.39 ab	0.25 b	398.8 a	2.33 cd	90
Fox 11	37.9	18.4	184	3.87 a	34.01 abc	0.52 ab	327.7 bc	3.50 abc	80
OHxF 87	25.4	12.9	232	2.87 ab	31.37 abc	0.41 ab	316.7 bcd	0.78 d	90
Pyrodwarf	34.6	11.9	189	2.55 ab	26.53 bcd	0.42 ab	307.7 cd	3.63 abc	80
Pyro 2-33	17.5	13.5	212	2.96 ab	23.89 cd	0.56 ab	313.2 bcd	5.70 ab	100
W. Nelis	30.2	13.6	164	1.82 ab	27.32 bcd	0.53 ab	295.5 cd	3.22 abc	90
<b>ANOVA</b> <sup>2</sup>									
Rootstock	NS	NS	NS	*	***	*	***	***	NS
Block	NS	*	NS	*	*	*	*	NS	NS

<sup>1</sup> Within columns, rootstock treatment means significantly different (Tukey HSD test,  $P \leq 0.05$ ).

<sup>2</sup> \*, \*\*, \*\*\* Indicate significance at  $P \leq 0.05$ , 0.01, and 0.001 respectively. NS indicates not significant ( $P > 0.05$ ).

Table 5: Effects of 2005 NC-140 rootstock planting on tree growth, flower clusters, number of fruit, root suckers, and tree survival among 3-year-old (4th leaf) Bosc pear trees, Talmage, California, 2008.

	Flower Clusters 4/8/08 (no./tree)	No. Fruit 9/5/08	Fruit Size 9/5/08 (g/fruit)	Tree Yield 9/5/08 (kg/tree)	TCSA 12/10/08 (cm <sup>2</sup> )	Yield Efficiency (kg/cm <sup>2</sup> )	Tree Height 12/10/08 (cm)	Root Suckers 4/8/08 (no./tree)	Tree Survival (%/10 trees)
<b>ROOTSTOCK<sup>1</sup></b>									
708-36	13.1	5.5	177	1.11	10.2	0.09	255	0.1	80
BM 2000	1.1	0.0	0	0.00	8.3	0.00	260	0.0	70
Horner-4	8.1	4.8	163	1.11	13.6	0.06	279	0.0	100
Fox 11	32.3	13.2	150	3.94	8.3	0.14	256	0.0	60
OHxF 87	16.8	10.1	194	2.61	11.5	0.14	228	0.0	80
Pyrodwarf	6.1	2.8	211	0.88	11.1	0.06	244	0.0	90
Pyro 2-33	7.0	0.5	185	0.25	8.5	0.01	237	0.0	80
<b>ANOVA<sup>2</sup></b>									
Rootstock	NS	NS	NS	NS	NS	NS	NS	NS	
Block	NS	NS	NS	NS	*	NS	**	NS	

<sup>1</sup> Within columns, rootstock treatment means significantly different (Tukey HSD test,  $P \leq 0.05$ ).

<sup>2</sup> \*, \*\*, \*\*\* Indicate significance at  $P \leq 0.05$ , 0.01, and 0.001 respectively. NS indicates not significant  $P > 0.05$ .

Table 6: Effects of 2005 NC-140 rootstock planting on tree growth, flower clusters, number of fruit, root suckers, and tree survival among 4-year-old (5th leaf) Bosc pear trees, Talmage, California, 2009.

	Flower Clusters 4/22/09 (no./tree)	No. Fruit 9/10/09	Fruit Size 9/10/09 (g/fruit)	Tree Yield 9/10/09 (kg/tree)	TCSA 12/10/08 (cm <sup>2</sup> )	Yield Efficiency (kg/cm <sup>2</sup> )	Tree Height 0/0/09 (cm)	Root Suckers 0/0/09 (no./tree)	Tree Survival 8/10/09 (%/10 trees)
<b>ROOTSTOCK<sup>1</sup></b>									
708-36	30.5 ab	11.1 ab	194 ab	2.15 ab	16.92	0.15 ab	272.5	0.00	80
BM 2000	17.3 b	2.4 b	221 a	0.53 b	15.70	0.04 b	292.9	0.10	70
Horner-4	24.0 ab	14.1 ab	190 ab	2.68 ab	23.17	0.20 b	308.1	0.50	100
Fox 11	7.3 b	2.4 b	192 ab	0.46 b	17.04	0.05 b	286.9	0.10	60
OHxF 87	48.4 a	21.3 a	186 ab	3.97 a	17.87	0.27 a	245.4	0.00	80
Pyrodwarf	21.4 ab	10.7 ab	189 ab	2.02 ab	19.13	0.11 b	274.1	0.00	90
Pyro 2-33	21.4 ab	8.0 ab	183 b	1.46 ab	16.47	0.11 b	290.5	0.00	80
<b>ANOVA<sup>2</sup></b>									
Rootstock	**	**	*	**	NS	**	NS	NS	
Block	NS	NS	*	NS	*	NS	NS	NS	

<sup>1</sup> Within columns, rootstock treatment means significantly different (Tukey HSD test,  $P \leq 0.05$ ).

<sup>2</sup> \*, \*\*, \*\*\* Indicate significance at  $P \leq 0.05$ , 0.01, and 0.001 respectively. NS indicates not significant  $P > 0.05$ .