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 1980's. 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 being tested in California include 708-36 (UK), BM2000 (Australia), Fox11 (Italy), Horner 4, OHxF69 and OHxF87 (Oregon), Pyro 2-33 and Pyrodwarf (Germany), and Winter Nelis as a standard (Sacramento County only). Survival rate was poorest for Pyro 2-33 and Fox11 in Mendocino County and for BM2000 and Fox11 in Sacramento County. Trees were larger in Sacramento County, possibly due to prolonged wet spring weather in 2006 and closer in-row spacing in Mendocino (1.6m vs. 3m). OHxF69, OHxF 87 and Horner 4 are thus far significantly the largest trees in Mendocino County and Winter Nelis, Fox 11 and Horner 4 the largest (numerically) in Sacramento County. Fox 11 and 708-36 had significantly more flower clusters and fruit in Sacramento County, and 708-36 and OHxF87 trended toward more precocity in the Mendocino County Bartlett trial based on number of fruit rather than flowers. Survival, growth, and yield data will again be collected in 2008.

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, 2007).

The NC140 Regional Rootstock Research Project (*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 2007 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 (Tables 1 and 2).

Data collection at each site from 2005-2007 varied slightly, but included percent survival, caliper/circumferences, height, number of flower clusters, number of fruit and number of root suckers. Canopy width was measured in Courtland.

RESULTS AND 2008 PLANS

2005 Bartlett Pear Rootstock Planting

1) North Coast - Talmage, Mendocino County; Cole loam, 5' x 10' spacing, north-south orientation (Tables 3-4)

As of 2007, survival rate has been good for most stocks. Exceptions are Fox 11 (2 dead) and Pyro 2-33 (3 dead). These were all small trees at planting ($\leq$ 1/2") and all died in 2005 or 2006. One 708-36 (1/2") and one Pyrodwarf (1/2") also died in 2006. 2006 was a very late, wet year (51 inches of rain in Ukiah Valley), which likely affected survival of weaker trees, both due to excessively wet soil and heavy summer annual weed growth, e.g. pigweed.

Horner 4, OHxF 69, and OHxF 87 have the significantly largest circumference; Horner 4 is significantly taller than others. 708-36 and OHxF 87 trended toward having the most fruit and highest yield efficiency (based on fruit number versus flowers); (BM2000 had the least fruit), however, there was no statistical difference among most rootstocks. Fox 11 had the most root suckers.

2) Sacramento Delta - Courtland, Yolo County; Sacramento Basin clay, 9' x 15' spacing, north-south orientation (Table 5)

As of December 2006, survival rate was greatest for Pyro 2-33 and Winter Nelis and lowest for 708-36 and BM2000 (3 dead for each). BM2000 had the most suckers. Trunk cross sectional area was 62% and height 39% greater than in Talmage, perhaps due to both prolonged wet weather in 2006 and closer in-row tree spacing. There were no significant differences among rootstocks, although Fox 11 was the largest tree at this site versus the smallest in Mendocino County. 708-36 and Fox 11 had the most flower clusters (31 and 17, respectively) and fruit (6/tree) in 2007.

2005 Golden Russet Bosc Pear Rootstock Planting

1) North Coast - Talmage, Mendocino County; Cole loam, 5' x 10' spacing, north-south orientation (Tables 6-7)

Overall survival rate is less than for Bartlett although it was planted only one day later (April 21 vs. April 20). 14 trees have died, all in 2005 (12) and 2006 (2). Worst survival is for Fox 11 (4 dead) and BM2000 (3 dead); best is for Horner 4 and Pyrodwarf. There were no significant differences in growth parameters.

2008 Plans

Yield efficiency will again be calculated. Percent survival, vigor, caliper, height, and presence of bloom and/or fruit will again be collected and summarized in 2008, along with the reasons for poor growth and/or death.

Data will be pooled with that from the Pacific Northwest and summarized for reporting to funding agencies, to NC140 at their annual meeting in Mexico in November 2008, and to growers in winter 2008. A field trip to the plots will be planned in summer 2008.

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LITERATURE CITED

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Table 1: Locations and included rootstocks, with % survival rates per 10 trees, NC 140 pear rootstock trials, California, 2005

Planted April 20-21, 2005; evaluated fall 2006

Rootstock	Origin	Sacramento[1] (Bartlett)	Talmage [2] (Bartlett)	Talmage (GR Bosc)
708-36	UK	70	90	80
BM2000	Australia	70	100	70
FOX 11	Italy	80	80	70
Horner 4	Hood River, OR	90	100	100
OHF 69	Oregon	-	100	-
OHF 87	Oregon	90	100	80
Pyro2-33	Germany	100	70	90
Pyrodwarf	Germany	80	90	90
Winter Nelis	USA	100	-	-

[1] Sacramento Clay, deep, 9' x 15' spacing
[2] Cole loam, drained, 5' x 10' spacing

Table 2: Locations and included rootstocks, NC140 pear rootstock trials, Oregon and Washington, 2005 and 2006 plantings.

Rootstock	Origin	2005 MCAREC[1] Anjou	2005 Cashmere Anjou	2005 Tonasket Bosc	2005 Yakima Bartlett	2006 MCAREC Anjou	2006 Cashmere Anjou	2006 Tonasket Bosc	2006 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	x	x		x	x	x	x	
Horner 4	Hood 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				

[1] Mid-Columbia Agricultural Research and Extension Center, Hood River, Oregon

Table 3: Effects of 2005 NC-140 rootstock planting on tree circumference, height, fruiting, root suckers and tree survival of 1-year-old Bartlett pear trees, Talmage, California, 2006.

Rootstock[1]	Trunk X-Sect. 4/18/06 (cm^2)	Tree Height 4/18/06 (cm)	No. Fruit 10/30/06 (no./tree)	Root Suckers 10/30/06 (no./tree)	No. Died	Tree Survival 10/30/06 (%/10 trees)
708-36	2.5 bc	122 abc	0.0	0.0	1	90
BM 2000	2.2 bc	113 c	0.0	0.1	0	100
Horner-4	3.9 a	134 ab	0.0	0.0	0	100
Fox 11	2.2 bc	104 c	0.1	0.1	0	80
OHxF 69	3.5 a	140 a	0.0	0.1	0	100
OHxF 87	3.1 ab	118 bc	0.0	0.1	0	100
Pyrodwarf	2.6 b	107 c	0.1	0.0	1	90
Pyro 2-33	1.6 c	104 c	0.0	0.0	2	70
ANOVA[2]						
Rootstock	***	***	NS	NS		
Block	NS	NS	NS	NS		

[1] Within columns, rootstock treatment means significantly different (Duncan multiple range test, $P \leq 0.05$).

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

Table 4: Effects of 2005 NC-140 rootstock planting on tree circumference, height, flower clusters, fruiting, root suckers, and tree survival of 2-year-old Bartlett pear trees, Talmage, California, 2007.

Rootstock[1]	Trunk X-sect. 2/05/07 (cm^2)	Tree Height 2/05/07 (cm)	Flower Clusters 4/16/07 (no./tree)	Fruit (no./tree)	Yield Efficiency (no.fruit/cm^2)	Root Suckers 10/03/07 (no./tree)	Tree Survival 4/18/06 (%/10 trees)	Tree Survival 10/03/07 (%/10 trees)
708-36	4.6 b	147 b	5.6 ab	8.5 a	1.9 a	0.0 ab	100	90
BM 2000	3.6 b	156 b	1.1 b	1.6 b	.05 b	0.1 ab	100	100
Horner-4	7.1 a	189 a	6.9 a	6.6 ab	0.9 ab	0.0 b	100	100
Fox 11	3.6 b	134 b	3.6 ab	5.5 ab	1.6 ab	0.4 a	80	80
OHxF 69	6.9 a	156 b	7.4 a	6.2 ab	0.9 ab	0.1 ab	100	100
OHxF 87	5.4 ab	145 b	6.1 ab	8.1 a	1.5 ab	0.0 b	100	100
Pyrodwarf	4.8 b	143 b	5.9 ab	6.0 ab	1.2 ab	0.0 ab	100	90
Pyro 2-33	3.5 b	137 b	2.1 ab	3.5 ab	1.1 ab	0.0 b	90	70
ANOVA[2]								
Rootstock	***	***	**	**	*	*		
Block	NS	*	NS	NS	NS	NS		

[1] Within columns, rootstock treatment means significantly different (Tukeys HSD test, $P \leq 0.05$).
[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. NS indicates not significant ($P > 0.05$).

Table 5: 2005 NC-140 rootstock effects on tree caliper, tree height, number of suckers, flower clusters and fruiting of 2-year-old Bartlett pear trees, Courtland, California, 2006-2007.

Rootstock[1]	Trunk X-Sect. 12/5/06 (cm^2)	Tree Height 12/5/06 (cm)	Tree Width 12/5/06 (cm)	Root Suckers 12/5/06 (no./tree)	Flower Clusters 3/15/07 (no./tree)	Fruit 7/12/07 (no./tree)
708-36	7.0	194	84.6	0.4	30.8 a	5.8 a
BM 2000	8.1	241	94.2	0.8	9.8 b	1.2 b
Horner-4	8.9	202	77.9	0.0	4.2 b	1.0 b
Fox 11	9.2	223	88.6	0.6	17.2 ab	6.4 a
OHxF 87	7.6	211	73.2	0.0	6.2 b	2.4 b
Pyrodwarf	6.8	201	70.9	0.3	10.1 b	2.4 b
2-33	5.9	183	64.3	0.0	4.8 b	0.3 b
W. Nelis	9.3	201	73.3	0.5	5.0 b	1.6 b
ANOVA[2]						
Rootstock	NS	NS	NS	NS	*	**
Block	*	NS	*	NS	NS	NS

[1] Within columns, rootstock treatment means significantly different (Fisher's LSD test, $P \leq 0.05$).
[2] *, **, *** 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 circumference, height, number of fruit, root suckers, and tree survival of 1-year-old Bosc pear trees, Talmage, California, 2006.

Rootstock[1]	Trunk X-Section 4/18/06	Tree Height 4/18/06	No. of Fruit 10/30/06	Root Suckers 10/30/06	No. Trees Died 2006	Tree Survival 4/18/06	Tree Survival 10/30/06
	(cm^2)	(cm)	(no./tree)	(no./tree)		(%/10 trees)	
708-36	2.6 ab	104	0.0	0.0	0	80	80
BM 2000	1.5 ab	85	0.0	0.0	0	70	70
Horner-4	3.6 a	95	0.0	0.2	0	100	100
Fox 11	1.7 ab	90	0.0	0.0	1	70	60
OHxF 87	3.1 ab	113	0.1	0.1	0	80	80
Pyrodwarf	2.6 ab	99	0.0	0.0	0	90	90
Pyro 2-33	1.2 b	94	0.0	0.0	1	90	80
ANOVA[2]							
Rootstock	**	NS	NS	NS			
Block	NS	NS	NS	NS			

[1] Within columns, rootstock treatment means significantly different (Tukeys HSD test, $P \leq 0.05$).
[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. NS indicates not significant ($P \leq 0.05$).

Table 7: Effects of 2005 NC-140 rootstock planting on tree circumference, height, flower clusters, fruiting, root suckers, and tree survival of 2-year-old Bosc pear trees, Talmage, California, 2007.

Rootstock[1]	Trunk X-Sect. 2/05/07	Tree Height 2/05/07	Flower Clusters 4/16/07	Fruit	Yield Efficiency	Root Suckers 10/03/07	Tree Survival 10/03/07	No. Trees Remaining
	(cm^2)	(cm)	(no./tree)	(no./tree)	(no.fruit/cm^2)	(no./tree)	(%/10 trees)	
708-36	3.8	139	0.1	0.0	0.0	0.1	80	8
BM 2000	2.7	127	0.3	0.6	0.3	0.0	70	7
Horner-4	5.0	137	0.1	0.1	0.0	0.0	100	10
Fox 11	3.4	142	0.2	0.7	0.1	0.0	60	6
OHxF 87	4.9	136	0.5	1.5	0.3	0.0	80	8
Pyrodwarf	4.5	136	0.0	0.0	0.0	0.0	90	9
Pyro 2-33	3.0	139	0.1	0.1	0.0	0.0	80	8
ANOVA[2]								
Rootstock	NS	NS	NS	NS	NS	NS		
Block	NS	NS	NS	NS	NS	NS		

[1] Within columns, rootstock treatment means significantly different (Tukeys HSD test, $P \leq 0.05$).
[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. NS indicates not significant ($P \leq 0.05$).