CALIFORNIA 2010 ANNUAL REPORT OF NC-140 COOPERATIVE REGIONAL PROJECT

PROJECT: **NC-140, California**

COOPERATING AGENCIES AND PRINCIPAL LEADERS:

R. Scott Johnson and Ted DeJong, University of California, Department of Plant Sciences, Davis, CA 95616
Rachel Elkins, University of California Cooperative Extension Farm Advisor, Lake County, Lakeport, CA 95453
Joe Grant, University of California Cooperative Extension Farm Advisor, San Joaquin County, Stockton, CA 95206

Objective 1. ROOTSTOCK – ENVIRONMENT INTERACTIONS

PROGRESS OF THE WORK AND PRINCIPAL – ACCOMPLISHMENTS

2003 Golden Delicious Apple Rootstock Planting

No trees died in 2010. However, the rootstocks that are way too vigorous for this semi-dwarf planting were removed early in the year. This included 18 trees on the rootstocks JM.2, PiAu 51-4, PiAu 56-83 and PiAu 36-2. Approximately half the trees in this planting have now died or been removed since planting in 2003. There are still three rootstocks, JM.4, 5 and 10 that are quite vigorous and are not very productive considering the size of their canopies (Table 1). In addition, JM.1, 7 and 8 show tremendous variability in tree size. This raises the question of whether these JM series rootstocks were mislabeled at the beginning of the experiment. Therefore, of all the more vigorous rootstocks in this planting, only CG.4210 shows promise for commercial use in California. It has had good production and reasonable fruit size the last few years (Table 1). The rootstocks that maintain tree vigor in the range of M.9 to M.26 and also appear to have high yield efficiency are CG.3041, CG.5179, CG.5935, G.16 and J-TE-H.

Table 1. 2003 NC-140 Golden Delicious apple rootstock planting at Kearney Ag Center – 2009 & 2010 yield, fruit weight and trunk circumference measurements.

Rootstock	2009 Yield (kg/tree)	2010 Yield (kg/tree)	2009 Fruit Weight (g)	2010 Fruit Weight (g)	10/10 Trunk Circumference (cm)
B.9	1.6 e	1.6 e	105 d	121 c	7.6 d
J-TE-G	3.0 e	5.6 e	149 a-c	155 a-c	11.3 d
Bud.62-396	9.0 c-e	8.9 de	151 a-c	148 bc	15.4 d
M.9T337	19.3 bc	17.8 b-e	161 a-c	159 a-c	20.3 cd
CG.3041	14.2 c-e	23.5 a-c	148 a-d	162 a-c	21.9 cd
M.9Pajam2	16.5 b-e	18.2 a-e	145 a-d	165 a-c	22.7 b-d
J-TE-H	23.2 bc	20.2 a-d	157 a-c	169 ab	24.5 b-d
CG.5179	24.0 bc	27.9 ab	158 a-c	163 a-c	26.4 b-d
G.16	32.3 ab	22.6 a-c	137 b-d	144 bc	28.4 b-d
PiAu 51-11	15.3 c-e	15.0 b-e	146 a-d	166 ab	28.4 b-d
CG.5935	19.0 bc	34.1 ab	137 b-d	162 a-c	28.8 b-d
M.26	25.3 a-c	37.2 ab	113 cd	149 a-c	32.0 a-d
JM.8	5.6 de	10.3 c-e	157 a-c	165 a-c	33.0 a-c
JM.1	10.8 c-e	14.4 b-e	163 ab	195 a	34.3 a-c
JM.7	7.3 c-e	11.1 c-e	154 a-c	167 ab	37.4 a-c
CG.4210	31.2 ab	43.2 a	153 a-c	165 a-c	39.5 ab
JM.5	39.7 a	18.5 a-e	149 a-d	156 a-c	49.7 ab
JM.10	18.1 b-d	20.0 a-e	173 a	171 ab	49.7 a
JM.4	22.9 bc	30.7 ab	184 a	183 a	50.8 a

2009 Redhaven Peach Rootstock Planting and Physiology Study

The trees grew very well in 2010. A few fruit were left on each tree, but not enough for commercial production. In 2011 we will be able to crop the trees heavily. No trees died in 2010, but several on *Prunus americana* looked somewhat weak. During an accidental flooding of the field in August, two of these trees fell over, suggesting a weak root system. The two trees were staked up and now appear reasonably healthy. This is the only rootstock that had some root suckers (data not shown). Six of the rootstocks show no statistical reduction in tree size compared to Lovell (Table 2). The remaining stocks show a gradation of tree size, ranging from semi to full dwarfing. Trees of Redhaven, Cresthaven and Crimson Lady on Lovell rootstocks grew very well and will be ready for physiology studies in 2011.

Table 2. 2009 NC-140 Redhaven peach rootstock trial – 2010 yield, fruit weight and trunk circumference measurements.

Rootstock	2010 Yield (kg/tree)	2010 Fruit weight (g)	10/10 Trunk Circumference (cm)
Prunus americana	3.9 f	213 a	17.7 f
Krymsk 1	7.6 d-f	170 f	20.0 ef
Controller 5	9.0 c-e	204 a-c	20.0 ef
HBOK 32	5.4 ef	171 ef	22.2 de
HBOK 10	8.7 c-e	199 a-d	24.4 d
Mirobac	7.3 d-f	188 c-f	25.0 cd
Penta	7.3 d-f	184 d-f	25.1 cd
KV010-127	15.0 a	214 a	28.0 bc
Viking	10.2 b-d	190 b-e	29.3 ab
Atlas	10.9 a-d	191 b-d	29.4 ab
Krymsk 86	9.8 cd	207 a-c	29.4 ab
Guardian	10.5 b-d	190 b-e	30.1 ab
KV010-123	14.0 ab	217 a	30.4 ab
Brights Hybrid 5	12.6 a-c	207 ab	31.6 a
Lovell	11.0 a-d	185 d-f	32.2 a

Related Rootstock Work

The peach rootstock breeding program includes a large number of selections from a wide array of crosses. In 2001, several of these with O'Henry peach grafted on top looked to be extremely promising. The trees ranged in size from very dwarfing to semi dwarfing and all had excellent fruit size. More than 20 of these have been identified and were planted in a large replicated trial in 2003, 2004 and 2005. Controller 5 and 9 were released under patent in 2004. Several more are now ready for release that are about 70 to 80% of the tree size of Nemaguard.

2005 Bartlett Pear Rootstock Planting

1) North Coast - Talmage, Mendocino County, Cole loam (Tables 3-5)

The rootstock regrowth of one OHxF 69 tree that died back early in 2009 flowered and produced fruit in 2010. Overall, flowering increased by 28%, fruiting by 99%, and tree yield by 87% compared to 2009. Fruit size decreased by 2% and fruit was generally small (less than 200 grams), typical for the season due to cold spring weather which delayed fruit development. High yield efficiencies reflected the heavy crop load on relatively small trees in the high density planting. Horner 4 and BM 2000 had the most flower clusters, and Horner 4 the most fruit, nearly twice the average yield of most of the other rootstocks, and the largest TCSA. 708-36 and Pyro 2-33 had the least number of flower clusters,

and 708-36 the least number of fruit, lowest yield, and the smallest TCSA. Pyrodwarf and BM2000 had the highest yield efficiency and OHxF69 the lowest. Fruit firmness and sugar was measured in 2010. 708-36 fruit was firmest. OHx87 fruit was sweetest and Horner-4 fruit the least sweet, perhaps reflecting high vigor.

Compared to cumulative 2005-2009 yields, 2010 yields increased appreciably for BM2000 (68%), Pyro 2-33 (44%), Horner 4 (39%), Pyrodwarf (38%), and. Fox 11 (37.5%). OHxF69 had a modest increase (21%) and OHxF87 (1.7%) and 708-36 (-32%) yields stayed static or actually declined. 2011 yields will provide insight into whether stagnating or declining yields are due to 1) reaching full crop load potential, 2) declining vigor or health, or 3) weather-related phenology effects during bloom and early fruit set. Average fruit size has been equal for all rootstocks, hence it is difficult thus far to implicate fruit size, leaving number of fruit as the major discernible factor.

Table 3: Cumulative effects of 2005 NC-140 rootstock planting on average fruit size, trunk cross sectional area, tree yield, yield efficiency, root suckers, and tree survival of 4-year-old (5th leaf) Bartlett pear trees, Talmage, California, 2005-2009.

	Average Fruit Size (g/fruit)	2009 TCSA (cm^2)	Average Cumulative Yield (kg/tree)	Average Cumulative Yield Efficiency[3] (kg/cm^2)	Root Suckers (cum. no./tree)	Tree Survival (%)
ROOTSTOCK[1]						
708-36	161	14.0 c	8.3 bc	0.57 ab	0.0 b	90 ab
BM 2000	162	17.6 bc	6.2 c	0.34 b	0.1 ab	100 a
Horner-4	190	34.0 a	16.9 a	0.49 ab	0.0 b	100 a
Fox 11	185	17.1 bc	8.0 bc	0.48 ab	0.2 a	80 bc
OHxF 69	141	20.9 b	8.5 bc	0.34 b	0.1 ab	100 a
OHxF 87	164	16.9 bc	11.4 b	0.68 a	0.0 b	100 a
Pyrodwarf	161	16.6 c	9.6 bc	0.56 ab	0.0 b	90 ab
Pyro 2-33	183	16.1 c	7.6 bc	0.45 ab	0.0 b	70 c
ANOVA[2]						
Rootstock	NS	***	***	***	*	***
Block	NS	*	***	*	NS	***

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, P<0.05). Duncan multiple range test for SQRT (root suckers+1).
[2] *, **, *** Indicate significance at P<0.05, 0.01, and 0.001 respectively. NS indicates not significant P>0.05.
[3] Based on cumulative yield (2005-09) and final TCSA (2009).

Table 4: Effects of 2005 NC-140 rootstock planting on flower clusters, number and size of fruit, yield, truck cross-sectional area, yield efficiency, tree height, root suckers, and tree survival among 5-year-old (6th leaf) Bartlett pear trees, Talmage, California, 2010.

	Flower Clusters 4/22/10 (no./tree)	No. Fruit 8/29/10	Fruit Size 8/29/10 (g/fruit)	Yield 8/29/10 (kg/tree)	TCSA 11/03/10 (cm^2)	Yield Efficiency (kg/cm^2)	Tree Height[3] 11/05/10 (cm)	Root Suckers 11/03/10 (no./tree)	Tree Survival 8/29/10 (%/10 trees)
ROOTSTOCK[1]									
708-36	111 b	50 c	158	6.3 d	15.8 d	0.41 bc	226 c	0.1	90
BM 2000	204 a	117 b	168	19.2 b	25.1 bc	0.76 a	264 ab	0.6	100
Horner-4	233 a	170 a	169	28.0 a	42.6 a	0.68 ab	269 a	0.1	100
Fox 11	146 ab	82 bc	161	12.8 bcd	21.5 bcd	0.59 abc	250 abc	0.7	80
OHxF 69	154 ab	74 bc	133	10.7 cd	28.7 b	0.33 c	246 abc	1.1	90
OHxF 87	162 ab	77 bc	154	11.6 cd	19.7 cd	0.61 abc	230 c	0.2	100
Pyrodwarf	169 ab	110 b	142	15.5 bc	20.9 bcd	0.78 a	245 abc	0.0	90
Pyro 2-33	103 b	78 bc	193	13.6 bcd	21.8 bcd	0.65 abc	239 bc	0.0	70
ANOVA[2]									
Rootstock	***	***	NS	***	***	***	***	NS	
Block	NS	**	NS	**	**	NS	NS	NS	

[1] Within columns, rootstock treatment means significantly different (Tukey 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: Effects of 2005 NC-140 rootstock planting on fruit pressure and sugar among 5-year-old (6th leaf) Bartlett pear trees, Talmage, California, 2010.

	Firmness (lb) 8/30/10	Brix (degrees) 8/30/10
ROOTSTOCK[1]		
708-36	20.5 a	14.3 ab
BM 2000	17.9 bc	13.3 bc
Horner-4	17.2 c	12.9 c
Fox 11	19.1 ab	13.5 bc
OHxF 69	19.1 abc	13.6 bc
OHxF 87	18.2 bc	15.1 a
Pyrodwarf	18.8 abc	14.5 ab
Pyro 2-33	18.6 abc	14.1 abc
ANOVA[2]		
Rootstock	***	***
Block	*	NS

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, $P \leq 0.05$).
[2] *, **, *** Indicate significance at $P \leq 0.05$, 0.01, and 0.001 respectively. NS indicates not significant $P > 0.0$

2005 'Golden Russet' Bosc Pear Rootstock Planting

1) North Coast-Talmage, Mendocino County; Pinole-Yokayo-Redvine sandy loam (Tables 6-8)

Survival is less than in the Bartlett trial. One BM 2000 tree died in 2010. Yields have thus far been much less than Bartlett yields. Flower clusters increased by 55%, number of fruit by 202%, and yield by 196% compared to 2009. The only significant difference in 2010 was in yield efficiency (although individual TCSA and yield averages were equal). Efficiencies were low overall but OHxF87 was the most efficient and Horner 4 the least. There were no significant differences among rootstocks for firmness, °Brix, or russeting.

Table 6: Cumulative effects of 2005 NC-140 rootstock planting on average fruit size, tree yield, trunk cross sectional area, yield efficiency, root suckers and tree survival of 4-year-old (5th leaf) 'Golden Russet' Bosc pear trees, Talmage, California, 2005-2009.

	Average Fruit Size (g/fruit)	Average Cumulative Yield (kg/tree)	2009 TCSA (cm^2)	Average Cumulative Yield Efficiency[3] (kg/cm^2)	Root Suckers (cumulative no./tree)	Tree Survival (%)
ROOTSTOCK[1]						
708-36	160	3.7 ab	18.6	0.21 ab	0.2	80 abc
BM 2000	80	0.7 b	16.3	0.02 b	0.2	70 bc
Horner-4	142	3.5 ab	23.2	0.14 b	0.7	100 a
Fox 11	149	2.7 ab	18.1	0.11 b	0.2	62 c
OHxF 87	165	6.9 a	18.2	0.36 a	0.1	80 abc
Pyrodwarf	167	2.8 ab	18.5	0.15 b	0.0	90 ab
Pyro 2-33	126	1.9 b	16.6	0.11 b	0.0	84 ab
ANOVA[2]						
Rootstock	NS	*	NS	***	NS	***
Block	NS	NS	NS	NS	NS	***

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

Table 7: Effects of 2005 NC-140 rootstock planting on flower clusters, number and size of fruit, tree yield, trunk cross-sectional area, yield efficiency, tree height, root suckers, tree survival among 5-year-old (6th leaf) Bosc pear trees, Talmage, California, 2010.

	Flower Clusters 4/23/10 (no./tree)	No. Fruit 9/15/10	Fruit Size 9/15/10 (g/fruit)	Tree Yield 9/15/10 (kg/tree)	TCSA 11/03/10 (cm^2)	Yield Efficiency[3] (kg/cm^2)	Tree Height 11/05/10 (cm)	Root Suckers 11/03/10 (no./tree)	Tree Survival 9/15/10 (%/10 trees)
ROOTSTOCK[1]									
708-36	51	41	147	7.8	24.9	0.27 ab	260 ab	0.0	80
BM 2000	27	20	185	3.5	29.3	0.14 ab	284 a	0.2	60
Horner-4	24	23	193	4.4	36.8	0.12 b	285 a	0.1	100
Fox 11	43	33	152	5.6	28.5	0.16 ab	285 a	0.1	60
OHxF 87	58	45	186	8.8	25.4	0.31 a	247 b	0.0	80
Pyrodwarf	38	31	182	5.9	28.7	0.20 ab	272 ab	0.0	90
Pyro 2-33	22	23	163	3.5	25.2	0.14 ab	268 ab	0.0	80
ANOVA[2]									
Rootstock	NS	NS	NS	NS	NS	*	**	NS	
Block	NS	NS	*	NS	NS	NS	*	NS	

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

[3] Tukey HSD test, $P \leq 0.10$

Table 8: Effects of 2005 NC-140 rootstock planting on fruit firmness, sugar and russet severity among 5-year-old (6th leaf) Bosc pear trees, Talmage, California, 2010.

	Firmness (lb) 9/16/10	Brix (degrees) 9/16/10	Rating (Russeting) 9/16/10
ROOTSTOCK[1]			
708-36	17.4	11.7	2.4
BM 2000	16.8	14.3	2.4
Horner-4	17.4	13.8	2.5
Fox 11	17.7	10.8	2.4
OHxF 87	17.9	14.8	3.3
Pyrodwarf	18.3	14.5	2.5
Pyro 2-33	19.2	12.3	2.2
ANOVA[2]			
Rootstock	NS	NS	NS
Block	***	NS	NS

[1] Within columns, rootstock treatment means significantly different (Tukey HSD test, $P \leq 0.05$)
[2] NS indicates not significant $P > 0.05$.

Work Planned for 2011 - Data collection and rootstock evaluation will continue in 2011. Procedures will again follow guidelines established by the NC140 Technical Committee. A 5-year summary of results from the Bartlett and Bosc trials in California, Chihuahua (Mexico), New York, and Washington was presented at the ISHS International Pear Symposium in Neuguen, Patagonia, Argentina in November 2010 (poster).

2010 Benton Cherry Rootstock and Training Systems Planting

A sweet cherry high density training systems trial was established in 2010 in southern Sacramento County, California (Approx. 38°17'23"N, 121°33'25"W). Soil at the trial site is moderately well-drained Valpac Loam (Fluvaquentic Haplozeroll). The orchard is irrigated with good quality well water distributed by a full coverage "rotator" sprinkler system to meet annual evaporative demand at 10 to 14 day intervals. A 1.5m wide weed-free strip is maintained in tree rows with pre- and post-emergence herbicides. Orchard middles are maintained by periodic mowing of a mixed sod of resident perennial and annual grasses.

The trial includes rootstocks Gisela 3, 5, 6, and 12 and the scion cultivar is Benton. Finished and unheaded nursery trees were planted (1.5 X 4.8 m) on March 11, 2010 and a 4-wire, 2.4 m vertical trellis (for Tall Spindle and UFO systems) was installed shortly thereafter. Training systems being imposed and evaluated are Tall Spindle and KGB for Gi 3, 5, and 6 rootstocks and UFO for Gi 3, 5, 6, and 12. The trial design is a randomized complete block design with six 4-tree replications of the ten rootstock x training system combinations. Experimental blocking is across the tree rows.

System-appropriate tree training operations were performed during spring and summer 2010. Growth, flowering yield data gathering will begin this winter using the two center trees in each plot.

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