



ANNUAL REPORT TO NC-140

Massachusetts Agricultural Experiment Station

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PROGRESS & PRINCIPAL ACCOMPLISHMENTS

1998 NC-140 Apple Rootstock Trial

As part of the 1998 NC-140 Apple Rootstock Trial, a planting of Gala on three rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center in 1998. These trees are on a non-irrigated site, and have not performed as well as desired in previous years, but they yielded well in 2005 (average of 32 kg per tree) with good fruit size (average of 158 g). The experiment was a randomized-complete-block design with ten replications. Means from 2005 (8th growing season) are included in Table 1.

Rootstock significantly affected trunk cross-sectional area (TCA), with trees on G.16 significantly larger than those on M.9 or M.9 EMLA. Cumulative (1998-2005) root suckering was not affected by rootstock through 2005. Yields per tree in 2005 were not different among trees on the three rootstocks; however, on a cumulative

basis (1999-2005), trees on G.16 yielded significantly more than those on M.9 or M.9 EMLA. In 2005 and cumulatively (1999-2005), trees on the M.9 strains were more yield efficient than trees on G.16. In 2005, rootstock did not affect fruit size, but on average (1999-2005), G.16 resulted in smaller fruit size than did M.9 or M.9 EMLA.

1999 NC-140 Dwarf Apple Rootstock Trial

As part of the 1999 NC-140 Dwarf Apple Rootstock Trial, a planting of McIntosh on 11 rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center in 1999. Trees in this trial have performed well (average 2005 yield of 39 kg per tree with 148-g average fruit size) with very little tree loss (one to dogwood borer and one to a mower). The planting included six replications in a randomized-complete-block design. Means from 2005 (7th growing

Table 1. Trunk cross-sectional area, suckering, yield, yield efficiency, and fruit weight in 2005 of Gala trees on various rootstocks in the Massachusetts planting of the 1998 NC-140 Apple Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.^z

Rootstock	Trunk cross-sectional area (cm ²)	Root suckers (no./tree, 1998-2005)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
			2005	Cumulative (1999-2005)	2005	Cumulative (1999-2005)	2005	Average (1999-2005)
G.16	27.8 a	1.4 a	37.1 a	96 a	1.33 b	3.39 b	149 a	127 b
M.9	17.8 b	1.3 a	29.2 a	71 b	1.66 a	4.03 a	167 a	160 a
M.9 EMLA	16.8 b	1.0 a	31.0 a	70 b	1.77 a	4.13 a	157 a	156 a

^z Means were separated within columns by Tukey's HSD ($P = 0.05$).

Table 2. Trunk cross-sectional area, suckering, yield, yield efficiency, and fruit weight in 2005 of McIntosh trees on several rootstocks in the Massachusetts planting of the 1999 NC-140 Dwarf Apple Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.^z

Rootstock	Trunk cross-sectional area (cm ²)	Root suckers (no./tree, 1999-2005)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
			2005	Cumulative (2001-05)	2005	Cumulative (2001-05)	2005	Average (2001-05)
CG.3041	33.9 bcd	1.6 b	44.7 abc	91 bc	1.33 a	2.70 abc	156 a	160 ab
CG.4013	57.4 a	6.2 a	60.6 a	151 a	1.06 a	2.69 abc	149 a	157 ab
CG.5179	40.5 bc	4.0 ab	53.7 ab	124 ab	1.33 a	3.06 ab	142 a	156 ab
CG.5202	46.4 ab	1.3 b	50.2 abc	120 ab	1.11 a	2.65 abc	145 a	157 ab
G.16N	29.1 cd	0.0 b	28.0 c	63 c	0.89 a	2.04 bc	151 a	159 ab
G.16T	28.7 cd	0.8 b	36.3 bc	78 bc	1.26 a	2.80 abc	161 a	157 ab
M.26 EMLA	33.6 bcd	0.0 b	31.9 c	64 c	0.94 a	1.88 c	147 a	157 ab
M.9 NAKBT337	19.4 d	1.4 b	24.5 c	50 c	1.32 a	2.73 abc	153 a	167 a
Supporter 1	22.2 d	0.0 b	28.1 c	72 c	1.19 a	3.12 ab	145 a	151 ab
Supporter 2	24.6 d	1.0 b	30.8 c	81 bc	1.26 a	3.30 a	136 a	141 b
Supporter 3	28.0 cd	0.3 b	37.7 bc	95 bc	1.35 a	3.43 a	143 a	150 ab

^z Means were separated within columns by Tukey's HSD ($P = 0.05$).

Table 3. Trunk cross-sectional area, suckering, yield, yield efficiency, and fruit weight in 2005 of McIntosh trees on several rootstocks in the Massachusetts planting of the 1999 NC-140 Semidwarf Apple Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.^z

Rootstock	Trunk cross-sectional area (cm ²)	Root suckers (no./tree, 1999-2005)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
			2005	Cumulative (2001-05)	2005	Cumulative (2001-05)	2005	Average (2001-05)
CG.4814	24.8 b	16.5 b	32.7 b	91 b	1.32 a	3.68 a	161 a	167 a
CG.7707	32.9 b	3.0 b	39.4 ab	89 bc	1.21 ab	2.70 b	151 ab	169 a
G.30N	54.9 a	6.3 b	53.6 a	134 a	0.99 abc	2.50 b	142 b	159 a
M.26 EMLA	30.2 b	0.0 b	25.6 b	57 c	0.86 bcd	1.90 bc	145 b	162 a
M.7 EMLA	60.6 a	35.8 a	28.0 b	78 bc	0.48 d	1.31 c	155 ab	167 a
Supporter 4	56.7 a	4.0 b	36.6 ab	83 bc	0.67 cd	1.53 c	147 b	162 a

^z Means were separated within columns by Tukey's HSD ($P = 0.05$).

season) are included in Table 2.

At the end of the 2005 season, largest trees were on CG.4013 and CG.5202, and the smallest were on M.9 NAKBT337, Supporter 1, and Supporter 2. Trees on G.16 were slightly, but not significantly smaller than those on M.26 EMLA, and trees on CG.3041 were similar in size to those on M.26 EMLA. Cumulative suckering (1999-

2005) was greatest from CG.4013. CG.4013, CG.5179, and CG.5202 resulted in the greatest yield per tree in 2005 and cumulatively (2001-05), and M.9 NAKBT337, Supporter 1, M.26 EMLA, and G.16N resulted in the least. In 2005, rootstock did not affect yield efficiency, but cumulatively (2001-05), the most efficient trees were on Supporter 2 and Supporter 3, and the least efficient were

on M.26 EMLA. Rootstock did not affect fruit size in 2005, but on average (2001-05), largest fruit were from trees on M.9 NAKBT337, and smallest were from trees on Supporter 2, with all other rootstocks resulting in intermediate average fruit size.

1999 NC-140 Semidwarf Apple Rootstock Trial

As part of the 1999 NC-140 Semidwarf Apple Rootstock Trial, a planting of McIntosh on six rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center in 1999. Trees in this trial have performed reasonable well (average 2005 yield of 36 kg per tree with 150-g average fruit size); however, leaning has been an issue with some. The planting included six replications in a randomized-complete-block design. Means from 2005 (7th growing season) are included in Table 3.

At the end of the 2005 season, largest trees were on M.7 EMLA, Supporter 4, and G.30N, and the smallest were on M.26 EMLA, CG.4814, and CG.7707. Greatest cumulative (1999-2005) root suckering was observed from trees on M.7 EMLA. G.30N resulted in the most yield per tree in 2005 and cumulatively (2001-05), and M.26 EMLA resulted in the least. Trees on CG.4814, CG.7707, and G.30N were the most yield efficient in 2005, and CG.4814 was the most efficient cumulatively (2001-

05). Average fruit weight (2001-05) was not affected by rootstock, but in 2005, trees on CG.4814 produced the largest fruit, and those on G.30N, M.26 EMLA, and Supporter 4 produced the smallest. Tree lean (data not shown) ranged from 6° for trees on M.7 EMLA to 21° for trees on CG.7707; however, variability was high, and no statistically significant differences were observed.

2002 NC-140 Apple Rootstock Trial

As part of the 2002 NC-140 Apple Rootstock Trial, a planting of Gala on 11 rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center in 2002. Trees are growing well in this irrigated block, but fruit set was lighter than expected this year (average yield of 7 kg per tree with 133-g average fruit size). The planting included seven replications in a randomized-complete-block design. Means from 2005 (4th growing season) are included in Table 4.

After the 2005 growing season, largest trees were on PiAu51-4 and smallest were on B.9 (Europe) and B.9 (Treco). Cumulative (2002-05) root suckering was not affected significantly by rootstock. Yield in 2005 was greatest from trees on B.9 (Treco), B.9 (Europe), and M.26 NAKB and least from trees on P.14 and Supporter 4. Cumulatively (2004-05), yield was greatest from trees

Table 4. Trunk cross-sectional area, suckering, yield, yield efficiency, and fruit weight in 2005 of Gala trees on several rootstocks in the Massachusetts planting of the 2002 NC-140 Apple Rootstock Trial. All values are least-squares means, adjusted for missing subclasses and crop load in the case of fruit weight in 2005.^z

Rootstock	Trunk cross-sectional area (cm ²)	Root suckers (no./tree, 2002-05)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
			2005	Cumulative (2004-05)	2005	Cumulative (2004-05)	2005	Average (2004-05)
B.9 (Europe)	9.6 c	0.0 a	8.1 a	11.2 a	0.80 a	1.11 a	126 ab	136 ab
B.9 (Treco)	11.2 c	0.1 a	8.9 a	11.2 a	0.82 a	1.05 ab	138 ab	149 ab
M.26 EMLA	18.2 b	0.3 a	6.7 ab	8.4 ab	0.34 b	0.43 bc	121 ab	126 ab
M.26 NAKB	20.9 ab	0.3 a	8.1 a	10.7 a	0.43 ab	0.57 abc	105 b	111 b
M.9 Bergmer 756	17.3 bc	0.3 a	5.5 ab	7.5 ab	0.33 b	0.45 bc	151 ab	154 a
M.9 RN29	15.2 bc	3.7 a	7.0 ab	9.7 ab	0.43 b	0.61 abc	153 a	158 a
M.9 NAKBT337	14.6 bc	0.0 a	4.6 ab	6.0 ab	0.31 b	0.39 c	158 a	154 a
P.14	20.4 ab	0.3 a	1.5 b	2.2 b	0.08 b	0.16 c	124 ab	125 ab
PiAu51-11	17.5 bc	0.2 a	2.8 ab	3.5 ab	0.16 b	0.21 c	129 ab	125 ab
PiAu51-4	26.8 a	0.0 a	3.8 ab	4.1 ab	0.13 b	0.15 c	130 ab	126 ab
Supporter 4	15.5 bc	0.0 a	1.9 b	2.8 ab	0.12 b	0.22 c	124 ab	126 ab

^z Means were separated within columns by Tukey's HSD ($P = 0.05$).

2003 NC-140 Apple Rootstock Physiology Trial

As part of the 2003 NC-140 Apple Rootstock Physiology Trial, a planting of Gibson Golden Delicious on three rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center in 2003. Trees in this trial grew very poorly during their first two seasons. The trees grew well in 2005, but they still were not allowed to fruit. The planting included ten trees of each rootstock

Table 5. Trunk cross-sectional area in October, cumulative suckering, yield, and fruit weight in 2005 of Redhaven trees on several rootstocks in the Massachusetts planting of the 2002 NC-140 Peach Rootstock Trial. All values are least-squares means, adjusted for missing subclasses and crop load in the case of fruit weight.^z

Rootstock	Trunk cross-sectional area (cm ²)	Root suckers (no./tree, 2002-04)	Yield per tree (kg)	Yield efficiency (kg/cm ² TCA)	Fruit weight (g)
Adesto 101	44.5 bc	0.1 a	0.8 c	0.02 c	181 ab
Cadaman	73.4 a	0.0 a	13.1 a	0.17 a	189 ab
Lovell	68.9 a	0.0 a	8.3 ab	0.12 ab	197 ab
MRS 2/5	50.8 b	0.6 a	3.4 bc	0.07 bc	211 a
Penta	45.4 bc	1.4 a	1.7 c	0.04 bc	171 ab
Pumiselect	36.6 bcd	0.5 a	2.2 c	0.05 bc	142 b
VSV-1	22.2 d	0.3 a	1.1 c	0.04 bc	190 ab
VVA-1	33.5 cd	0.3 a	2.6 c	0.08 abc	194 ab

^z Means were separated within columns by Tukey's HSD ($P = 0.05$).

on B.9 (Tresco), B.9 (Europe), and M.26 NAKB and least from trees on P.14. Yield efficiency in 2005 and cumulatively (2004-05) was greatest for trees on B.9 (Tresco) or B.9 (Europe). Fruit size in 2005 and on average was greatest for the three M.9 strains and least for trees on M.26 NAKB.

2002 NC-140 Peach Rootstock Trial

As part of the 2002 NC-140 Peach Rootstock Trial, a planting of Redhaven on eight rootstocks was established at Clarkdale Fruit Farm (Deerfield, Massachusetts) in 2002. The trees have grown reasonably well, but suffered a complete crop loss in 2004 (due to winter cold temperatures) and a partial crop loss in 2005 (due to spring frost). Average yield in 2005 was only 4 kg per tree, but average fruit size was 184 g. The planting included eight replications in a randomized-complete-block design. Means from 2005 (4th growing season) are included in Table 5.

After the 2005 season, the largest trees were on Cadaman and Lovell, significantly larger than trees on the other rootstocks. Smallest trees were on VVA-1 and VSV-1. Rootstock did not affect root suckering (2002-04). Yield per tree in 2005 was greatest from trees on Cadaman and Lovell. Likewise, trees on these two rootstocks were the most yield efficient in 2005. Largest fruit were harvested from trees on MRS 2/5, and the smallest were from trees on Pumiselect. To date, the greatest tree loss (50%) was of trees on Pumiselect. Mortality of trees on other rootstocks was low.

in a completely random design. Means from 2005 (3rd growing season) are included in Table 6.

Rootstock did not affect root suckering (2003-05), but at the end of the 2005 season, trees on G.16 and M.26 EMLA had similar TCA and were significantly larger than those on M.9 NAKBT337.

Table 6. Trunk cross-sectional area and root suckering in 2005 of Gibson Golden Delicious trees on three rootstocks in the Massachusetts planting of the 2003 NC-140 Apple Rootstock Physiology Trial. All values are least-squares means, adjusted for missing subclasses.^z

Rootstock	Trunk cross-sectional area (cm ²)	Root suckers (no./tree)
G.16	7.0 a	0.0 a
M.26 EMLA	8.0 a	0.0 a
M.9 NAKBT337	5.0 b	0.0 a

^z Means were separated within columns by Tukey's HSD ($P = 0.05$).

Table 7. Trunk cross-sectional area, yield, yield efficiency, and fruit weight in 2005 of Rogers Red McIntosh trees on several rootstocks planted in 1996. All values are least-squares means, adjusted for missing subclasses and crop load in the case of fruit weight in 2005.^z

Rootstock	Trunk cross-sectional area (cm ²)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
		2005	Cumulative (1998-2005)	2005	Cumulative (1998-2005)	2005	Average (1998-2005)
V.1	30.7 bc	29.4 ab	105 ab	1.00 a	3.47 ab	136 a	132 ab
V.2	44.5 a	32.0 ab	123 ab	0.75 b	2.72 c	136 a	142 ab
V.3	21.2 c	22.0 b	84 b	1.03 a	4.15 a	132 a	128 b
V.7	51.1 a	40.1 a	139 ab	0.80 ab	2.76 bc	136 a	141 ab
M.26 EMLA	41.0 ab	42.0 a	142 a	1.03 a	3.49 ab	149 a	144 a

^z Means were separated within columns by Tukey's HSD ($P = 0.05$).

1996 McIntosh Rootstock Trial

In 1996, a trial was established at the University of Massachusetts Cold Spring Orchard Research & Education Center including Rogers Red McIntosh on V.1, V.2, V.3, V.7, and M.26 EMLA. In this last season for this trial, trees performed well, with average yield of 33 kg per tree and average fruit size of 138 g. The experiment was a randomized-complete-block design with seven replications. Means from 2005 (10th growing season) are included in Table 7.

Largest were on V.7, V.2, and M.26 EMLA, and the smallest were on V.3 and V.1. Yield per tree in 2005 was greatest from trees on M.26 EMLA and V.7 and least from trees on V.3. Cumulatively (1998-2005), trees on

M.26 EMLA yielded the most, and those on V.3 yielded the least. The most yield efficient trees in 2005 and cumulatively (1998-2005) were on V.3, V.1, and M.26 EMLA, and the least efficient were on V.2. Rootstock did not affect fruit weight in 2005, but average (1998-2005), largest fruit were harvested from trees on M.26 EMLA, and smallest were from trees on V.3.

2002 Massachusetts-New Jersey Cameo Rootstock Trial

In 2002, a trial was established in Belchertown, MA and Pittstown, NJ including Cameo on B.9, G.16, and M.9 NAKBT337. In the first four years of this trial, trees have grown well, with somewhat low yields in 2005 (8 kg per

Table 8. Trunk cross-sectional area, root suckering, yield, yield efficiency, and fruit weight in 2005 of Cameo trees on three rootstocks planted in 2002 as part of the MA/NJ Cameo Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.^z

Rootstock	Trunk cross-sectional area (cm ²)	Root suckers (no./tree, 2002-05)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
			2005	Cumulative (2003-05)	2005	Cumulative (2003-05)	2005	Average (2003-05)
B.9	7.9 b	0.4 a	9.3 ab	16.1 ab	1.13 a	1.96 a	197 a	191 a
G.16	13.6 a	0.3 a	11.0 a	19.9 a	0.83 ab	1.49 ab	198 a	188 a
M.9 NAKBT337	9.3 b	2.1 a	4.9 b	11.6 b	0.54 b	1.31 b	219 a	204 a

^z Means were separated within columns by Tukey's HSD ($P = 0.05$).

tree on average) and good fruit size in 2005 (205 g on average). The experiment was a randomized-complete-block design with ten replications at each site. Massachusetts data from 2005 (4th growing season) are presented in Table 8.

Trees on G.16 were larger than those on either B.9 or M.9 NAKBT337. Cumulative (2002-05) root suckering

was not affected by rootstock. Greatest yields per tree in 2005 and cumulatively (2003-05) were harvested from trees on G.16, and the lowest were from trees on M.9 NAKBT337. Yield efficiency in 2005 and cumulatively (2003-05) were greatest for trees on B.9 and least for trees on M.9 NAKBT337. Fruit size in 2005 or on average (2003-05) was not affected by rootstock.

USEFULNESS OF FINDINGS

We have defined further the characteristics of several rootstocks grown under Massachusetts conditions with McIntosh, Gala, and Cameo as apple scion cultivars and Redhaven as a peach scion cultivar. Several rootstocks in the older plantings show great promise for potential commercial adoption.

In addition to the economic benefits associated with

the greater yield efficiency, fruit size, and management efficiency of trees on some of these dwarfing rootstocks, significant benefits are realized by growers in Massachusetts selling fruit using pick-your-own techniques. These fully dwarf trees seem particularly suited to pick-your-own marketing, providing for significantly less loss due to fruit drop and poor quality.

WORK PLANNED FOR 2006

All existing plantings will be maintained in 2006, with the exception of the 1996 McIntosh Rootstock Trial. No new trials are planned. Final reports of the 1995

Massachusetts-Maine-Nova Scotia Rootstock Trial and the 1996 McIntosh Rootstock Trial will be developed for publication.

PUBLICATIONS

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