



Massachusetts Agricultural Experiment Station

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PROGRESS & PRINCIPAL ACCOMPLISHMENTS

1994 NC-140 Apple Rootstock Trial

As part of the 1994 NC-140 Apple Rootstock Trial, a planting of Gala on 17 rootstock was established at the University of Massachusetts Cold Spring Orchard Research & Education Center in 1994. The planting included ten replications in a randomized-complete-block

design.

Trunk cross-sectional area (TCA), root suckering, yield, yield efficiency, and fruit weight all were affected in 2002 by rootstock (Table 1). Largest trees were on V.1 and M.26 EMLA, and the smallest trees were on P.22, M.27 EMLA, B.491, and P.16. The greatest amount of cumulative (1994-2002) root suckering resulted from trees

Table 1. Trunk cross-sectional area, suckering, yield, yield efficiency, and fruit weight in 2002 of Gala trees on several rootstocks in the Massachusetts planting of the 1994 NC-140 Apple Rootstock Trial. All values are least-squares means, adjusted for missing subclasses and for crop load in the case of 2002 fruit weight.^z

Rootstock	Trunk cross-sectional area (cm ²)	Root suckers (no./tree, 1994-2002)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
			2002	Cumulative (1996-2002)	2002	Cumulative (1996-2002)	2002	Average (1996-2002)
B.9	38.7 ef	12.5 bcde	41 defg	139 def	1.05 abc	3.64 ab	133 ab	145 cd
B.469	28.5 fg	7.9 cde	25 fgh	102 fg	0.88 abc	3.66 ab	123 bc	137 d
B.491	18.6 gh	8.0 cde	17 h	72 gh	0.96 abc	3.97 a	133 ab	139 d
M.9 EMLA	56.0 cde	11.3 bcde	50 cde	182 bcde	0.89 abc	3.30 ab	143 ab	159 abc
M.9 Fleuren 56	42.0 def	32.9 ab	47 cdef	155 def	1.13 ab	3.77 a	150 a	158 abc
M.9 Pajam 1	58.8 cd	25.3 abcd	58 bcd	195 bcde	1.02 abc	3.31 ab	146 a	161 ab
M.9 Pajam 2	73.0 b	36.3 a	73 ab	243 ab	1.02 abc	3.38 ab	150 a	161 ab
M.9 RN29	64.3 c	22.9 abcde	63 bc	224 bc	0.99 abc	3.47 ab	150 a	165 a
M.9 NAKBT337	51.7 cde	17.2 abcde	51 bcde	177 cde	0.98 abc	3.42 ab	146 a	159 abc
M.26 EMLA	85.5 ab	1.8 e	69 bc	223 bc	0.80 bc	2.68 b	146 a	162 a
M.27 EMLA	12.7 gh	6.4 de	11 h	48 gh	0.86 abc	4.00 a	133 ab	137 d
Mark	34.6 efg	20.0 abcde	27 efgh	119 efg	0.75 bc	3.42 ab	127 abc	147 abcd
O.3	51.7 cde	29.5 abc	60 bcd	206 bcd	1.17 a	4.04 a	143 ab	146 bcd
P.2	52.0 cde	5.7 de	49 cdef	167 cde	0.95 abc	3.22 ab	146 a	156 abc
P.16	23.1 fgh	31.2 abc	21 gh	85 fgh	0.91 abc	3.71 ab	140 ab	149 abcd
P.22	8.0 h	8.7 cde	6 h	30 h	0.72 c	3.73 a	106 c	118 e
V.1	93.7 a	18.9 abcde	93 a	299 a	0.98 abc	3.22 ab	146 a	166 a

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

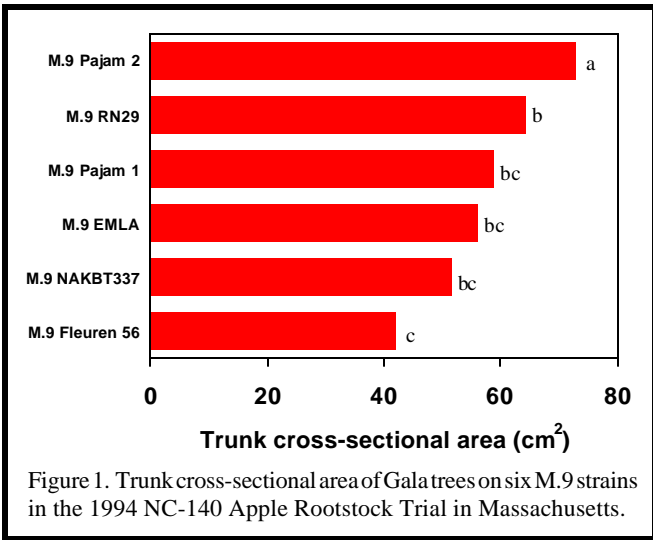


Figure 1. Trunk cross-sectional area of Gala trees on six M.9 strains in the 1994 NC-140 Apple Rootstock Trial in Massachusetts.

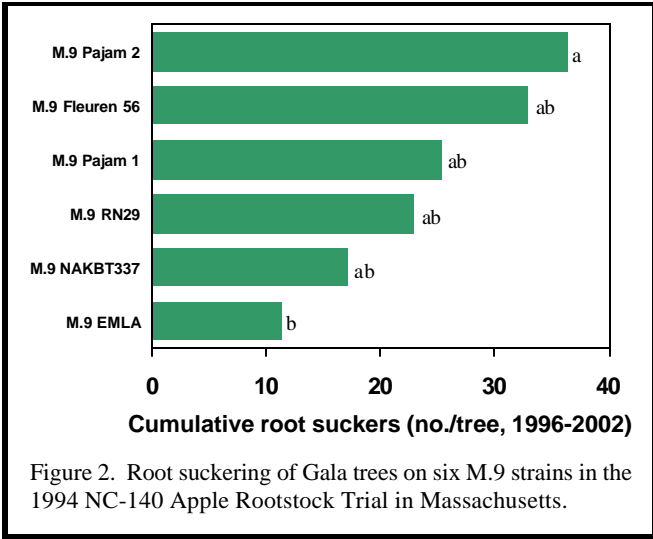


Figure 2. Root suckering of Gala trees on six M.9 strains in the 1994 NC-140 Apple Rootstock Trial in Massachusetts.

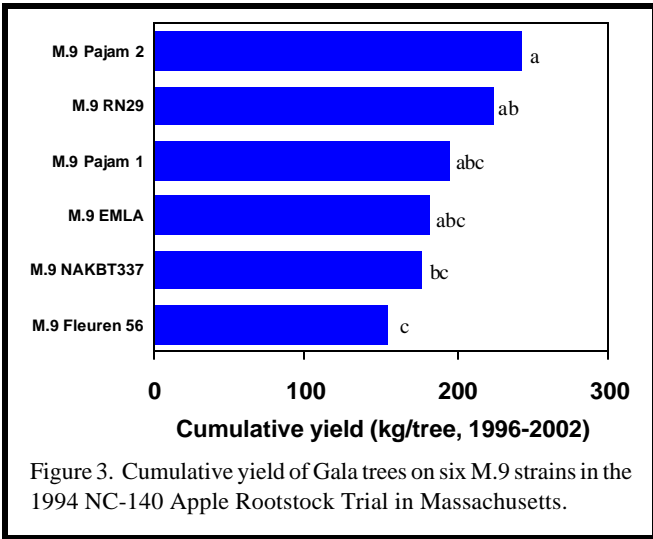


Figure 3. Cumulative yield of Gala trees on six M.9 strains in the 1994 NC-140 Apple Rootstock Trial in Massachusetts.

resulted in the greatest yields in 2002, and P.22, M.27 EMLA, B.491, and P.16 resulted in the lowest. Cumulatively (1996-2002), the greatest yields came from trees on V.1 and M.9 Pajam 2, and the lowest yields came from trees on P.22, M.27 EMLA, B.491, and P.16. In 2002, O.3, and M.9 Fleuren 56 resulted in the most yield efficient trees, and P.22, and M.26 EMLA resulted in the least efficient. Cumulatively (1996-2002), the most efficient trees were on O.3, M.27 EMLA, B.491, M.9 Fleuren 56, and P.22, and the least efficient were on M.26 EMLA. In 2002, M.9 Fleuren 56, M.9 Pajam 2, M.9 RN29, M.9 Pajam 1, M.9 NAKBT337, M.26 EMLA, P.2, and V.1 resulted in the largest fruit, and P.22, B.469, and Mark resulted in the smallest. Average fruit weight for the fruiting life of the planting (1996-2002) was greatest for trees on V.1, M.9 RN29, and M.26 EMLA and smallest for trees on P.22.

Since six strains of M.9 are included in this experiment, it is interesting to study variation among them. TCA varied significantly among the six strains (Figure 1), with trees on M.9 Pajam 2 74% larger than trees on M.9 Fleuren 56. Root suckering was greatest from trees on M.9 Pajam 2 and least from trees on M.9 EMLA (Figure 2). Cumulative yield per tree (Figure 3) followed a similar trend to TCA; and, trees of the six strains were similarly yield efficient.

1994 NC-140 Peach Rootstock Trial

As part of the 1994 NC-140 Peach Rootstock Trial, a planting of Redhaven on 13 rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center in 1994. The planting included eight replications in a randomized-complete-

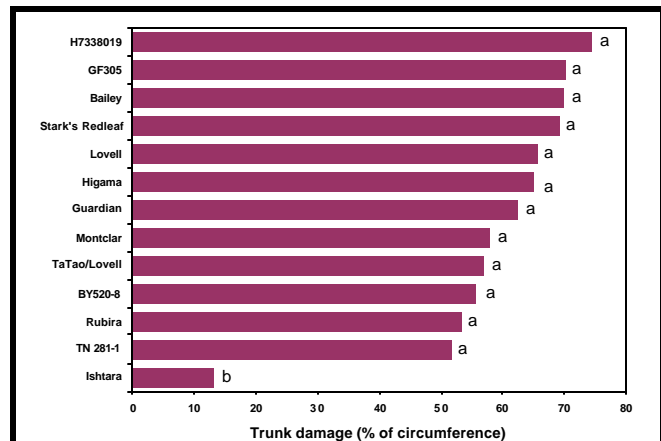


Figure 4. Trunk damage in Redhaven trees in the 1994 NC-140 Peach Rootstock Trial in Massachusetts.

on M.9 Pajam 2, M.9 Fleuren 56, P.16, and O.3, and the least resulted from trees on M.26 EMLA, M.27 EMLA, P.2, B.469, B.491, and P.22. V.1 and M.9 Pajam 2

Table 2. Trunk cross-sectional area, suckering, yield, yield efficiency, and fruit weight in 2002 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, 1998-2002)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
			2002	Cumulative (1999-2002)	2002	Cumulative (1999-2002)	2002	Average (1999-2002)
G.16	13.5 a	0.4 a	13.2 a	24.0 a	0.92 b	1.71 a	104 b	107 b
M.9	7.5 b	0.3 a	11.3 a	17.8 a	1.50 a	2.32 a	124 a	125 a
M.9 EMLA	6.7 b	0.3 a	9.5 a	14.5 a	1.47 a	2.21 a	119 a	121 a

^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 2002 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, 1999-2002)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
			2002	Cumulative (2001-02)	2002	Cumulative (2001-02)	2002	Average (2001-02)
CG.3041	10.6 bcd	0.0 a	8.4 ab	11.5 ab	0.81 a	1.10 a	135 a	142 a
CG.4013	19.7 a	0.5 a	13.6 a	23.5 a	0.68 a	1.17 a	149 a	153 a
CG.5179	14.4 abc	0.3 a	10.1 ab	18.6 ab	0.69 a	1.29 a	130 a	150 a
CG.5202	16.6 ab	0.0 a	7.7 ab	17.1 ab	0.50 a	1.06 a	133 a	152 a
G.16N	8.8 cd	0.0 a	4.5 b	9.9 b	0.47 a	1.01 a	124 a	159 a
G.16T	10.0 bcd	0.0 a	4.4 b	10.1 b	0.44 a	1.04 a	114 a	139 a
M.26 EMLA	10.8 bcd	0.0 a	3.2 b	5.3 b	0.30 a	0.48 a	125 a	132 a
M.9 NAKBT337	5.7 d	0.0 a	2.8 b	5.5 b	0.51 a	1.01 a	132 a	156 a
Supporter 1	8.8 cd	0.0 a	4.7 b	10.1 b	0.49 a	1.06 a	115 a	127 a
Supporter 2	10.6 bcd	0.5 a	6.8 ab	12.7 ab	0.70 a	1.30 a	125 a	128 a
Supporter 3	11.7 bc	0.0 a	7.0 ab	15.8 ab	0.60 a	1.34 a	136 a	155 a

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

block design. These trees were removed in December 2001, and final data for tree performance were presented in the 2001 report. At removal, trees were pulled from the ground, and a chainsaw cut was made across the rootstock shank at about the original ground level. The degree of trunk damage (primarily from peach tree borer) was assessed visually and recorded as percent of the trunk circumference affected. Figure 4 presents these data. Significant trunk damage occurred during the life of trees

on 12 of the rootstocks. Trees on Ishtara showed significantly less damage than trees on any of the other rootstocks. This difference appears to be related to a true resistance to peach tree borer in Ishtara.

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

Table 4. Trunk cross-sectional area, suckering, yield, yield efficiency, and fruit weight in 2002 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, 1999-2002)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
			2002	Cumulative (2001-02)	2002	Cumulative (2001-02)	2002	Average (2001-02)
CG.4814	9.3 b	9.2 a	9.3 ab	12.8 a	0.96 a	1.29 a	148 ab	152 a
CG.7707	10.5 b	2.2 ab	7.9 ab	8.4 a	0.78 ab	0.83 ab	158 a	160 a
G.30N	19.4 a	0.2 b	10.6 a	14.0 a	0.55 abc	0.74 ab	156 ab	163 a
M.26 EMLA	9.1 b	0.0 b	3.9 b	5.2 a	0.41 bc	0.56 b	127 b	127 a
M.7 EMLA	19.7 a	8.7 a	4.0 b	6.6 a	0.20 c	0.31 b	151 ab	163 a
Supporter 4	18.3 a	0.3 b	5.2 ab	9.0 a	0.30 c	0.54 b	135 ab	157 a

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

University of Massachusetts Cold Spring Orchard Research & Education Center in 1998. The experiment was a randomized-complete-block design with ten replications.

Rootstock significantly affected TCA after the fifth growing season (2002) (Table 2), with trees on G.16 significantly larger than those on M.9 or M.9 EMLA. Cumulative (1998-2002) root suckering was similar among the three rootstocks. Yield in 2002 and cumulatively (2000-2001) were not affected by rootstock. In 2002, trees on M.9 and M.9 EMLA were significantly more yield efficient than those on G.16, but cumulatively (1999-2002), there were no significant differences. Both in 2002 and on average for the fruiting life of the trial (1999-2002), M.9 and M.9 EMLA resulted in larger fruit than G.16.

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. The planting included six replications in a randomized-complete-block design.

Rootstock significantly affected TCA and yield per tree after the fourth growing season (2002) but did not affect cumulative (1999-2002) root suckering, yield efficiency, or fruit size (Table 3). Largest trees were on CG.4013, CG.5202, and CG.5179, and the smallest were on M.9 NAKBT337, G.16N, and Supporter 1. CG.4013

Table 5. Trunk cross-sectional area at planting and in October, the number of usable feathery leaves at planting, and suckering in 2002 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.^z

Rootstock	Trunk cross-sectional area at planting (cm ²)	Usable feathery leaves at planting (no./tree)	Trunk cross-sectional area in October (cm ²)	Root suckers (no./tree, 2002)
B.9 (Europe)	1.0 c	0.0 a	1.3 bcd	0.0 a
B.9 (Tresco)	1.1 abc	0.4 a	1.4 abcd	0.0 a
M.26 EMLA	1.2 ab	1.9 a	1.6 abc	0.0 a
M.26 NAKB	1.4 a	1.9 a	1.9 a	0.0 a
M.9 Bergmer 756	1.0 c	0.0 a	1.3 bcd	0.1 a
M.9 RN29	1.4 a	0.7 a	1.8 ab	0.0 a
M.9 NAKBT337	0.8 cd	0.6 a	1.1 cd	0.0 a
P.14	1.2 abc	0.9 a	1.6 abc	0.0 a
PiAu 51-11	0.6 d	0.0 a	0.8 d	0.2 a
PiAu 51-4	1.2 abc	2.1 a	1.8 ab	0.0 a
Supporter 4	1.1 bc	0.9 a	1.4 abcd	0.0 a

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

Table 6. Trunk cross-sectional area at planting and in October and suckering in 2002 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.^z

Rootstock	Trunk cross-sectional area at planting (cm ²)	Trunk cross-sectional area in October (cm ²)	Root suckers (no./tree, 2002)
Adesto 101	0.5 bc	2.1 b	0.0 a
Cadaman	0.7 ab	4.2 a	0.0 a
Lovell	0.6 abc	3.9 a	0.0 a
MRS	0.8 a	2.4 b	0.1 a
Penta	0.6 abc	1.8 b	0.0 a
Pumiselect	0.4 c	2.7 b	0.0 a
VSV-1	0.7 ab	2.6 b	0.0 a
VVA-1	0.5 bc	2.1 b	0.3 a

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

resulted in the most yield in 2002 and cumulatively (2001-02), and M.9 NAKBT337, M.26 EMLA, G.16T, G.16N, and Supporter 1 resulted in the least.

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. The planting included six replications in a randomized-complete-block design.

Rootstock significantly affected TCA, root suckering yield, yield efficiency, and fruit size in 2002 (Table

4). Largest trees were on M.7 EMLA, G.30N, and Supporter 4, and the smallest were on M.26 EMLA, CG.4814, and CG.7707. Greatest cumulative (1999-2002) root suckering was observed from trees on CG.4814 and M.7 EMLA, with the least from trees on M.26 EMLA, G.30N, and Supporter 4. G.30N resulted in the most yield per tree in 2002, and M.26 EMLA and M.7 EMLA resulted in the least. Rootstock did not affect cumulative (2001-02) yield per tree. Trees on CG.4814 and CG.7707 were the most yield efficient in 2002, and trees on M.7 EMLA and Supporter 4 were the least efficient. Cumulative (2001-02) efficiency was not affected by rootstock. Weight was greatest of fruit from trees on CG.7707 and least of fruit from trees on M.26 EMLA. Average (2001-02) fruit weight was not affected by rootstock.

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. The planting included seven replications in a randomized-complete-block design.

Rootstock affected TCA at planting and at the end of

Table 7. Trunk cross-sectional area in 2002 of Cortland, Rogers Red McIntosh, Macoun, and Pioneer Mac trees on several rootstocks planted in 1995. All values are least-squares means adjusted for missing subclasses.^z

Rootstock	Cortland	Macoun	McIntosh	Pioneer Mac	Average
<i>Trunk cross-sectional area (cm²)</i>					
B.146	7.9	11.6	3.0	11.1	8.4 cd
B.469	15.2	14.0	16.1	16.0	15.4 c
B.491	9.0	13.0	11.2	10.1	10.8 cd
M.9	23.5	21.2	25.3	19.8	22.4 b
M.9 NAKBT337	20.7	21.5	23.8	27.4	23.4 b
Mark	39.1	38.2	36.4	43.8	39.4 a
P.2	23.3	23.4	19.2	27.3	23.3 b
P.16	3.8	5.1	4.9	7.2	5.2 d
P.22	6.4	6.2	6.5	6.3	6.3 d
V.1	39.2	44.7	46.3	46.3	44.1 a
V.3	16.9	17.6	17.6	20.9	18.3 b
Average	18.6 a	19.7 a	19.1 a	21.5 a	

^z Overall rootstock means and overall cultivar means were separated by Tukey's HSD ($P = 0.05$). Rootstock means were not separated within cultivar, since cultivar and rootstock did not interact significantly.

Table 8. Yield in 2002 and cumulative yield of Cortland, Rogers Red McIntosh, Macoun, and Pioneer Mac trees on several rootstocks planted in 1995. All values are least-squares means adjusted for missing subclasses.^z

Rootstock	Cortland	Macoun	McIntosh	Pioneer Mac	Average
<i>Yield per tree (2002, kg)</i>					
B.146	2.4 e	6.5 e	2.2 d	6.5 cd	4.4 d
B.469	15.1 de	11.5 e	14.9 bc	14.1 bcd	13.9 d
B.491	9.4 e	19.0 cde	10.4 cd	8.8 cd	11.9 d
M.9	25.2 abc	28.3 bc	23.0 ab	20.2 b	24.2 bc
M.9 NAKBT337	23.7 bc	13.6 de	22.3 ab	22.6 ab	20.6 c
Mark	34.4 a	32.9 b	25.4 a	24.1 ab	29.2 ab
P.2	23.1 bcd	29.3 bc	22.0 ab	23.2 ab	24.4 bc
P.16	6.4 e	7.0 e	6.4 cd	8.4 cd	7.0 d
P.22	7.1 e	9.1 e	7.0 cd	5.7 d	7.2 d
V.1	30.3 ab	53.2 a	25.6 a	30.6 a	34.9 a
V.3	19.6 cd	23.4 bcd	23.1 ab	17.6 bc	20.9 c
Average	17.9 a	21.3 a	16.6 a	16.5 a	
<i>Cumulative yield per tree (1997-2002, kg)</i>					
B.146	14 e	16 e	7 f	15 d	13 d
B.469	32 de	28 de	33 cde	28 cd	30 d
B.491	24 e	39 cd	24 def	21 d	27 d
M.9	51 bc	56 c	52 ab	41 abc	50 bc
M.9 NAKBT337	47 bcd	41 cd	45 bc	45 bc	44 c
Mark	86 a	74 ab	65 a	55 ab	70 a
P.2	53 bc	57 bc	42 bcd	48 ab	50 bc
P.16	17 e	17 e	20 ef	25 cd	20 d
P.22	21 e	15 e	18 ef	17 d	18 d
V.1	62 b	80 a	50 abc	57 a	62 ab
V.3	44 cd	50 c	52 ab	40 bc	46 c
Average	41 a	43 a	37 a	36 a	

^z Overall rootstock means and overall cultivar means were separated by Tukeys HSD ($P = 0.05$). Rootstock means within cultivar were separated by t test ($P = 0.01$).

the season but did not affect the number of usable feathers at planting or the root suckering in 2002 (Table 5). The largest trees at planting and at the end of the season were on M.26 EMLA, and the smallest were on PiAu 51-11 and M.9 NAKBT337.

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 planting included eight replications in a randomized-complete-block design. Rootstock affected TCA at planting and at the end of the growing season but did not affect root suckering in 2002 (Table 6). At planting, trees on MRS, VSV-1, and Cadaman were the largest, and

those on Pumiselect, VVA-1, and Adesto 101 were the smallest. At the end of the season, trees on Cadaman and Lovell were significantly larger than all other combinations.

1995 Massachusetts-Maine-Nova Scotia Scion/Rootstock Trial

In 1995, a trial was established at three locations (Belchertown, MA, Monmouth, ME, and Kentville, NS) including Rogers Red McIntosh, Cortland, Macoun, and Pioneer Mac on 11 different rootstocks. The experiment was a randomized-complete-block/split-plot design at each site, with cultivar as the whole plot and rootstock as the split plot. Each site included seven replications. Only Massachusetts data are presented in this report.

Table 9. Yield efficiency in 2002 and cumulative yield efficiency of Cortland, Rogers Red McIntosh, Macoun, and Pioneer Mac trees on several rootstocks planted in 1995. All values are least-squares mean adjusted for missing subclasses.^z

Rootstock	Cortland	Macoun	McIntosh	Pioneer Mac	Average
<i>Yield efficiency (2002, kg/cm² TCA)</i>					
B.146	0.47	0.65	0.48	0.55	0.54 c
B.469	1.05	0.67	0.97	0.92	0.90 abc
B.491	1.17	1.53	0.96	0.86	1.13 abc
M.9	1.17	1.34	0.90	1.05	1.11 abc
M.9 NAKBT337	1.08	0.81	1.08	0.89	0.96 abc
Mark	0.88	0.91	0.71	0.57	0.76 c
P.2	1.04	1.21	1.82	0.90	1.24 ab
P.16	1.43	1.44	1.26	0.97	1.28 a
P.22	1.13	0.68	1.09	0.98	0.97 abc
V.1	0.80	1.23	0.55	0.68	0.81 bc
V.3	1.17	1.34	1.33	0.84	1.17 abc
Average	1.04 a	1.07 a	1.01 a	0.84 a	
<i>Cumulative yield efficiency (1997-2002, kg/cm² TCA)</i>					
B.146	1.78	1.50	1.93	1.39	1.65 cd
B.469	2.36	1.98	2.21	1.85	2.10 bcd
B.491	3.08	3.03	2.13	2.14	2.59 bc
M.9	2.34	2.71	2.02	2.11	2.30 bc
M.9 NAKBT337	2.18	2.41	2.09	1.80	2.12 bcd
Mark	2.30	2.05	1.78	1.29	1.86 cd
P.2	2.37	2.49	3.15	1.88	2.47 bc
P.16	3.99	3.65	4.27	3.63	3.89 a
P.22	3.34	2.39	3.00	2.75	2.87 b
V.1	1.63	1.89	1.09	1.25	1.46 d
V.3	2.70	2.82	2.94	1.96	2.61 b
Average	2.55 a	2.45 a	2.42 a	2.08 a	

^z Overall rootstock means and overall cultivar means were separated by Tukey's HSD ($P = 0.05$). Rootstock means were not separated within cultivar, since cultivar and rootstock did not interact significantly.

TCA was not affected by cultivar or the interaction of cultivar and rootstock; however, rootstock affected TCA significantly (Table 7). Specifically, across all cultivars, the largest trees were on V.1 and Mark, and the smallest were on P.16 and P.22.

Yield in 2002 was affected by rootstock and the interaction of cultivar and rootstock, but not cultivar (Table 8). Over all cultivars, trees on V.1 and Mark yielded the most in 2002, and those on B.146, P.16, P.22, B.491, and B.469 yielded the least. Although significant, the interaction of rootstock and cultivar did not result in dramatic variation in the relative effects of rootstock from cultivar to cultivar. Cumulative yields (1997-2002) likewise were affected by rootstock and the interaction of cultivar and rootstock, but not by cultivar (Table 8). Over

all cultivars, Mark and V.1 resulted in the greatest cumulative yields per tree, and B.146, P.22, P.16, B.491, and B.469 resulted in the least. Although the interaction of cultivar and rootstock was statistically significant, as with yield per tree in 2002, little variation in rootstock response existed among cultivars. Yield efficiency in 2002 and cumulative yield efficiency (1997-2002) were affected by rootstock only (Table 9). The most efficient trees in 2002 and cumulatively were on P.16, and the least efficient were on V.1, Mark, and B.146.

In 2002, fruit weight was affected by cultivar, rootstock, and the interaction of rootstock and cultivar (Table 10). Across all rootstocks, Cortland produced the largest fruit in 2002, and Macoun produced the smallest. Across all cultivars, M.9 NAKBT337, M.9, V.1, V.3, and

Table 10. Fruit weight in 2002 and average fruit weight of Cortland, Rogers Red McIntosh, Macoun, and Pioneer Mac trees on several rootstocks planted in 1995. All values are least-squares means adjusted for missing subclasses and for crop load in the case of fruit weight in 2002.²

Rootstock	Cortland	Macoun	McIntosh	Pioneer Mac	Average
<i>Fruit weight (2002, g)</i>					
B.146	130 e	130 a	149 c	135 c	134 d
B.469	187 cd	134 a	167 abc	150 bc	160 bc
B.491	202 bc	156 a	156 bc	162 ab	169 abc
M.9	211 ab	154 a	180 a	174 ab	180 a
M.9 NAKBT337	225 a	144 a	176 a	178 a	181 a
Mark	209 ab	158 a	166 abc	162 ab	174 ab
P.2	210 ab	154 a	177 a	162 ab	176 a
P.16	192 c	154 a	167 abc	169 ab	170 ab
P.22	174 d	124 a	150 c	151 bc	150 cd
V.1	216 ab	156 a	170 ab	170 ab	178 a
V.3	217 ab	157 a	178 a	162 ab	178 a
Average	198 a	147 c	167 b	161 b	
<i>Average fruit weight (1997-2002, g)</i>					
B.146	168 d	129 a	122 f	152 bcd	143 d
B.469	195 c	158 a	157 bcd	154 bcd	166 bc
B.491	206 bc	153 a	156 bcd	157 abcd	168 b
M.9	222 a	147 a	175 ab	166 ab	177 ab
M.9 NAKBT337	218 ab	159 a	167 abc	172 a	179 ab
Mark	218 ab	155 a	165 abc	162 abc	175 ab
P.2	215 ab	146 a	156 cd	157 abcd	169 b
P.16	196 c	152 a	135 ef	141 d	156 cd
P.22	174 d	146 a	146 de	146 cd	153 cd
V.1	229 a	160 a	176 a	173 a	184 a
V.3	220 ab	151 a	164 abc	163 abc	175 ab
Average	205 a	151 b	156 b	158 b	

² Overall rootstock means and overall cultivar means were separated by Tukey's HSD ($P = 0.05$). Rootstock means within cultivar were separated by t test ($P = 0.01$).

P.2 resulted in the largest fruit, and B.146 and P.22 resulted in the smallest. Little variation in these relative differences existed among cultivars, except that within Macoun, rootstock did not affect fruit weight. Averaged across the fruiting life (1997-2002) of the trees, fruit weight was affected by cultivar, rootstock, and the interaction of rootstock and cultivar (Table 10). Over all rootstocks, Cortland fruit were significantly larger than those of the other three cultivars. Over all cultivars, V.1, M.9 NAKBT337, M.9, V.3, and Mark resulted in the largest fruit, and B.146, P.16, and P.22 resulted in the smallest. As in 2002, the relative rootstock effects were similar for Cortland, McIntosh, and Pioneer Mac, but rootstock did not affect Macoun fruit weight.

1995 Massachusetts-New Brunswick-Pennsylvania Ginger Gold Rootstock Trial

In 1995, a trial was established in Belchertown, MA, University Park, PA, and Bouctouche, NB including Ginger Gold on 10 rootstocks. The experiment was a randomized-complete-block design with 10 replications at each site. Only Massachusetts data are reported here.

At the end of the 2002 growing season, trees on Mark and V.1 were the largest, and those on B.469, P.16, P.22, B.491, and V.3 were the smallest (Table 11). In 2002 and cumulatively (1997-2002), Mark and V.1 resulted in the greatest yields per tree, and B.469, P.22, V.3, P.16, and B.491 resulted in the lowest yields. In 2002, yield

Table 11. Trunk cross-sectional area, yield, yield efficiency, and fruit weight in 2002 of Ginger Gold trees on several rootstocks planted in 1995. All values are least-squares means, adjusted for missing subclasses and for crop load in the case of fruit weight in 2002.^z

Rootstock	Trunk cross-sectional area (cm ²)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
		2002	Cumulative (1997-2002)	2002	Cumulative (1997-2002)	2002	Average (1997-2002)
B.9	32.6 b	27.0 b	62 c	0.85 b	1.99 b	229 a	231 a
B.469	5.5 c	6.0 d	13 d	1.09 ab	2.24 ab	160 c	131 c
B.491	10.3 c	14.2 cd	28 d	1.39 a	2.64 ab	219 ab	208 ab
M.9 NAKBT337	31.9 b	30.9 b	70 bc	1.08 ab	2.37 ab	235 a	226 ab
Mark	48.8 a	46.6 a	111 a	0.96 b	2.29 ab	212 ab	211 ab
P.2	28.3 b	25.1 bc	57 c	0.91 b	2.03 b	213 ab	216 ab
P.16	9.4 c	13.0 d	29 d	1.43 a	3.09 a	211 ab	196 b
P.22	9.6 c	9.1 d	21 d	0.98 ab	2.30 ab	194 b	196 b
V.1	48.0 a	43.5 a	93 ab	0.93 b	1.97 b	223 ab	225 ab
V.3	10.5 c	12.6 d	24 d	1.27 ab	2.15 b	207 ab	196 b

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

Table 12. Trunk cross-sectional area, yield, yield efficiency, and fruit weight in 2002 of Rogers Red McIntosh trees on several rootstocks planted in 1996. All values are least-squares means, adjusted for missing subclasses and for crop load in the case of fruit weight in 2002.^z

Rootstock	Trunk cross-sectional area (cm ²)	Yield per tree (kg)		Yield efficiency (kg/cm ² TCA)		Fruit weight (g)	
		2002	Cumulative (1998-2002)	2002	Cumulative (1998-2002)	2002	Average (1998-2002)
V.1	16.1 b	27.1 b	48 b	1.69 ab	3.07 ab	121 a	126 b
V.2	21.7 b	30.2 b	53 b	1.36 bc	2.35 b	124 a	135 ab
V.3	12.3 b	20.9 b	43 b	1.80 a	3.62 a	120 a	123 b
V.4	62.2 a	57.1 a	90 a	0.99 c	1.53 c	127 a	141 a
V.7	23.6 b	36.2 b	60 ab	1.48 ab	2.49 b	133 a	135 ab
M.26 EMLA	21.6 b	31.5 b	57 b	1.53 ab	2.77 b	125 a	135 ab

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

efficiency was greatest of trees on P.16 and B.491 and least of trees on B.9, P.2, V.1, and Mark. Cumulatively (1997-2002), trees on P.16 were the most yield efficient, and those on V.1, B.9, P.2, and V.3 were the least efficient. Weight in 2002 was greatest of fruit from trees on M.9 NAKBT337 and B.9, and least of fruit from trees on B.469. B.9 resulted in the greatest fruit weight averaged over the fruiting life of the trial (1997-2002), and B.469 resulted in the lowest.

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.4, V.7, and M.26 EMLA. The experiment was a randomized-complete-block design with seven replications.

After the seventh growing season, trees on V.4 had

Table 13. Trunk cross-sectional area at planting and in October in 2002 of Cameo trees on three rootstocks planted in 2002.^z

Rootstock	Trunk cross-sectional area at planting (cm ²)	Trunk cross-sectional area in October (cm ²)
B.9	1.4 b	1.8 b
G.16	1.5 b	2.0 ab
M.9 NAKBT337	1.8 a	2.3 a

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

2002 and cumulatively, and the largest average (1997-2002) fruit weight (Table 12). The most yield efficient trees in 2002 and cumulatively were on V.3. Rootstock did not affect fruit weight in 2002, but average (1998-2002) fruit weight was least from trees on V.3 and V.1.

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. The experiment was a randomized-complete-block design with ten replications at each site. Only Massachusetts data are presented here.

Rootstock affected trunk circumference at planting and at the end of the 2002 growing season (Table 13). Specifically, trees on M.9 NAKBT337 were significantly larger than those on B.9 or G.16 at planting, and were significantly larger than trees on B.9 at the end of the growing season.

the largest TCA, the greatest yield in 2002 and cumulatively (1998-2002), the lowest yield efficiency in

USEFULNESS OF FINDINGS

We have defined further the characteristics of several rootstocks grown under Massachusetts conditions with McIntosh, Pioneer Mac, Gala, Ginger Gold, Cortland, Macoun, 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 and fruit size 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 2003

All existing plantings will be maintained in 2003. No new trials are planned. A final report of the Massachusetts-Pennsylvania-New Brunswick Ginger Gold/Rootstock Trial will be developed for publication.

PUBLICATIONS

Autio, W.R. and J. Krupa. 2002. Performance of the V Series apple rootstocks during six growing seasons. *Fruit Notes of New England* 67(3):18-19.

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SPONSORED ACTIVITY

Autio, W. R. 2001-02. Coordination of two NC-140 rootstock trials. International Dwarf Fruit Tree Association, \$3,200.

Autio, W.R. 2001. Rootstock research in Massachusetts. Massachusetts Fruit Growers' Association Horticultural Research Fund, \$850.