Performance of Honeycrisp Apple trees on Several Budagovsky, Cornell-Geneva, and Pillnitz Rootstocks

An Update on the Massachusetts Planting of the 2010 NC-140 Apple Rootstock Trial

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As part of the 2010 NC-140 Honeycrisp Apple Rootstock Trial, a planting was established at the UMass Cold Spring Orchard Research and Education Center with 31 different rootstocks. These included two named clones from the Budagovsky series (B.9, B.10), seven unreleased Budagovsky clones (B.7-3-150, B.7-20-21, B.64-194, B.67-5-32, B.70-6-8, B.70-20-20, and B.71-7-22), four named Cornell-Geneva clones (G.11, G.41, G.202, and G.935), nine unreleased Cornell-Geneva clones (CG.2034, CG. 3001, CG.4003, CG.4004, CG.4013, CG.4214, CG.4814, CG.5087, and CG.5222), one named clone from the Pillnitz series (Supp.3), two unreleased Pillnitz clones (PiAu 9-90 and PiAu 51-11), and three Malling clones as controls (M.9 NAKBT337, M.9 Pajam 2, and M.26 EMLA). G.41, G.202, and G.935 were represented both by trees propagated from stool-bed liners (labeled as N) and from tissue-cultured liners (labeled as TC).

Budagovsky rootstocks are from the Michurinsk State Agrarian University in Michurinsk, Tambov Region, Russia. The breeding program began with I.V. Budagovsky making crosses in 1938, with the principle goal of developing rootstocks with enhanced winter hardiness. He released one of the best known Budagovsky Rootstocks, B.9, in 1962. The Cornell-Geneva Apple Rootstock Breeding Program is managed jointly by Cornell University and the United States Department of Agriculture. Several rootstocks have been released from this program, most with a high degree of disease resistance, particularly to the fire blight bacterium (*Erwinia amylovora*). The Pillnitz series of rootstocks (PiAu and Supporter) are from the Institut für Obstforschung Dresden-Pillnitz, Germany. The original material for this program came from discontinued breeding programs in Muncheberg and Naumburg. These earlier programs sought better horticultural characteristics and pest resistance.

The trial was planted in May 2010, at a tree spacing of 4'x12', and trees were trained on wire as tall spindles. Trees on B.70-20-20 were deemed too large after five years and were removed from the trial. This article presents data through 2016, the seventh growing season.

The results for 2016 and cumulatively are presented in Table 1. Tree size varied greatly, from the smallest trees on B.71-7-22 and the largest on B.64-194, with more than a ten-fold difference in trunk cross-sectional area between the two. Root suckering varied also, with some rootstocks producing very small amounts (B.64-194, B.10, CG.2034, G.41N, and PiAu 9-90) and others producing moderately large numbers of root suckers (CG.4214, G.202N, CG.4814, and G.202TC). The zonal chlorosis, typical of Honeycrisp, varied with rootstock also. In 2016, the least was seen on trees on B.7-3-150, and the most was seen on trees on G.935TC.

Yield was relatively low in 2016 because of the early spring cold temperatures. Greatest yields were harvested from trees on CG.3001, and the smallest yields were from trees on B.71-7-22. Cumulatively (2013-16), trees on CG.3001 were the highest yielding,

Table 1. Trunk cross-sectional area, cumulative root sucker number, zonal chlorosis, yield per tree, yield efficiency, and fruit weight in 2016 of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial at the UMass Cold Spring Orchard Research & Education Center, Belchertown, MA.

Rootstock	Trunk cross-sectional area (2016, cm^2)	Cumulative root suckers (2010-16, no.)	Zonal chlorosis (2016, %)	Yield per tree (2016, kg)	Cumulative yield per tree (2013-16, kg)	Yield efficiency (2016, kg/cm^2 TCA)	Cumulative yield efficiency (2013-16, kg/cm^2 TCA)	Fruit weight (2016, g)	Average fruit weight (2013-16, g)
B.9	8.6	13.7	24.2	7.6	30.4	0.9	3.5	180	228
B.10	14.5	0.6	25.0	12.9	52.2	0.9	3.7	233	240
B.7-3-150	31.9	2.5	12.8	13.4	50.7	0.4	1.6	222	264
B.7-20-21	27.3	6.5	29.6	9.9	55.0	0.3	2.1	193	236
B.64-194	34.8	0.0	20.7	11.2	50.4	0.3	1.4	222	248
B.67-5-32	33.1	1.8	18.9	9.1	46.7	0.3	1.5	217	256
B.70-6-8	33.2	1.2	18.2	12.5	61.6	0.4	1.9	220	251
B.71-7-22	2.3	7.0	52.3	1.3	6.3	0.6	2.7	85	163
G.11	11.8	13.5	31.9	12.9	53.7	1.1	4.5	181	238
G.41N	13.8	0.5	23.4	15.0	60.0	1.0	4.2	210	246
G.41TC	12.7	14.3	26.3	13.8	45.2	1.0	3.5	214	244
G.202N	27.0	40.7	50.7	11.3	88.3	0.5	3.3	205	249
G.202TC	17.7	30.0	25.7	15.2	64.6	0.8	3.6	196	219
G.935N	18.1	22.4	67.5	14.2	80.4	0.8	4.4	202	230
G.935TC	12.5	28.6	89.5	12.3	45.7	0.9	3.5	201	223
CG.2034	10.1	0.1	53.7	8.2	31.6	0.7	3.0	157	212
CG.3001	28.2	3.8	23.8	19.8	106.5	0.7	3.8	223	245
CG.4003	9.7	2.1	23.0	9.0	42.8	0.9	4.3	143	195
CG.4004	25.5	16.0	32.5	18.0	80.6	0.7	3.2	233	250
CG.4013	19.0	28.5	40.2	19.3	70.8	0.9	3.5	191	221
CG.4214	19.9	53.7	67.1	12.6	51.5	0.6	2.6	213	238
CG.4814	18.1	30.3	80.6	9.5	54.4	0.5	3.1	200	219
CG.5087	17.2	8.6	69.8	16.7	59.3	1.0	3.3	160	213
CG.5222	21.7	26.1	64.2	10.5	48.0	0.5	2.2	199	223
Supp.3	12.1	8.7	85.0	7.7	32.8	0.6	2.7	165	211
PiAu 9-90	24.4	1.0	66.5	6.8	20.2	0.3	0.9	168	157
PiAu 51-11	21.8	11.4	39.9	8.5	42.6	0.4	2.0	208	247
M.9 NAKBT337	13.6	25.3	69.2	12.1	51.8	0.9	3.8	197	237
M.9 Pajam 2	12.4	36.9	61.7	8.6	38.5	0.7	3.3	187	224
M.26 EMLA	14.0	14.2	49.8	8.3	37.2	0.6	2.7	214	231
Est. HSD ($P = 0.05$)	9.1	22.6	45.2	7.8	25.7	0.4	1.1	64	41

Within a column, mean differences greater than or equal to the Est. HSD are statistically significant (at odds of 19 to 1).

and those on B.71-7-22 were the lowest yielding.

Some of the difference in yield is simply related to tree size, so it often is more instructive to look at yield efficiency, which relates yield to trunk cross-sectional area. The most efficient trees in 2016 were on G.11, and the least efficient were on B.7-20-21, B.64-194, B.67-5-32, and PiAu 9-90. Cumulatively (2013-16), the most efficient trees were on G.11, G.935N, and G.41N, and the least efficient were on PiAu 9-90. Generally, fruit size was not much affected by rootstock, except fruit from trees on B.71-7-22 (the smallest tree) were consistently small (2016 and on average from 2013 through 2016).

Using the data in Table 1 to compare 30 rootstocks is difficult at best. To potentially see differences more easily, trunk cross-sectional area and cumulative yield per tree are presented graphically in Figure 1. Rootstocks are arranged from the most vigorous at the top to the least vigorous at the bottom. It is easy to see that some rootstocks stand out relative to yield within a size

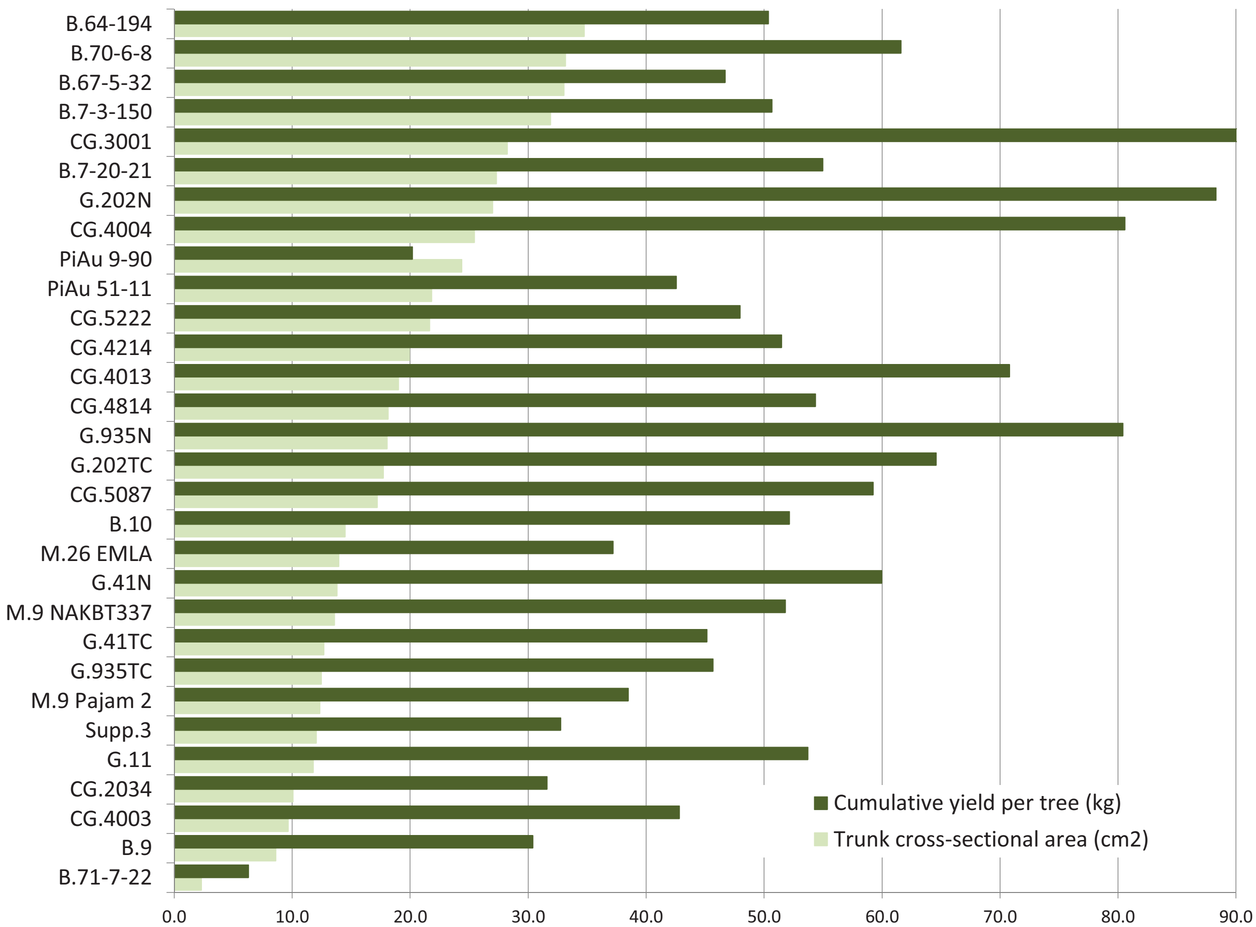

Figure 1. Trunk cross-sectional area and cumulative yield in 2016 of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial.

category.

In Table 2, we have presented the rootstocks by size category (sub-dwarf, small dwarf, moderate dwarf, large dwarf, and semi-dwarf), and within category, we have arranged them from most to least yield efficient. This table gives a much clearer view of these rootstocks. For a semi-dwarf tree, CG.3001, G.202N, and CG.4004 performed the best. Among the large dwarfs, G.935N was the most yield efficient. For the moderate dwarfs, G.11 and G.41N were the best performers, and CG.4003 was the best for the small dwarfs.

This trial has shown that the new Budagovsky rootstocks do not perform particularly well. All, but B.10 and B.71-7-22, are quite vigorous with low yield efficiency. B.10 performed comparably to M.9 NAKBT337, but not as well as G.11 and G.41N. For a very weak rootstock, B.71-7-22 was not very yield efficient and resulted in small fruit.

None of the Pillnitz rootstocks performed well when compared to other rootstocks in their respective size category.

Cornell-Geneva rootstocks performed best in the semi-dwarf, large dwarf, moderate dwarf, and small dwarf categories. The standouts were CG.3001, G.202, CG.4004, G.935, G.11, G.41, and CG.4003. Certainly, the unnamed CG.3001, CG.4004, and CG.4003 are worth of further trial, and the named G.202, G.935, G.11, and G.41 are ready for more significant commercial planting. It is important, however, to note that G.935 is susceptible latent virus that may be in the scionwood. The use of virus indexed scion wood is essential.

Table 2. Rootstocks distributed among five vigor classes based on 2016 trunk cross-sectional area. Within class, rootstocks are ordered highest to lowest based on cumulative (2011-16) yield efficiency. Standouts are highlighted in yellow.

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Vigor category	Rootstock	Trunk cross-sectional area (2016, cm^2)	Cumulative yield efficiency (2011-16, kg/cm^2 TCA)
Semi-dwarf	CG.3001	28.2	3.8
	G.202N	27.0	3.3
	CG.4004	25.5	3.2
	CG.5222	21.7	2.2
	B.7-20-21	27.3	2.1
	PiAu 51-11	21.8	2.0
	B.70-6-8	33.2	1.9
	B.7-3-150	31.9	1.6
	B.67-5-32	33.1	1.5
	B.64-194	34.8	1.4
	PiAu 9-90	24.4	0.9
Large dwarf	G.935N	18.1	4.4
	G.202TC	17.7	3.6
	CG.4013	19.0	3.5
	CG.5087	17.2	3.3
	CG.4814	18.1	3.1
	CG.4214	19.9	2.6
Moderate dwarf	G.11	11.8	4.5
	G.41N	13.8	4.2
	M.9 NAKBT337	13.6	3.8
	B.10	14.5	3.7
	G.935TC	12.5	3.5
	G.41TC	12.7	3.5
	M.9 Pajam 2	12.4	3.3
	M.26 EMLA	14.0	2.7
	Supp.3	12.1	2.7
Small dwarf	CG.4003	9.7	4.3
	B.9	8.6	3.5
	CG.2034	10.1	3.0
Sub-dwarf	B.71-7-22	2.3	2.7