An Evaluation of Cornell-Geneva and Budagovsky Apple Rootstocks with Honeycrisp, the 2010 NC-140 Apple Rootstock Trial after Five Years

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The NC-140 Multi-State Research Committee has studied apple, peach, cherry, and pear rootstocks for nearly 40 years. Results from NC-140 trials form the basis for nearly all current North American rootstock recommendations. In 2010, an NC-140 apple rootstock trial was established at 14 locations with Honeycrisp as the scion variety and seven locations with Fuji. It included numerous named and numbered rootstock clones from the Budagovsky (Russia), Geneva (USA), and Pillnitz (Germany) breeding programs in comparison to standard Malling rootstocks.

Materials & Methods

As part of the 2010 NC-140 Apple Rootstock Trial, a planting of Honeycrisp on 31 rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center in Belchertown, MA. In 2010, trees in this planting grew relatively little, but growth has been good in the subsequent seasons. The planting includes four replications in a randomized-complete-block design, with up to three trees of a single rootstock per replication.

Yield per tree was counted and weighed in 2013 and 2014, so data presented include both the 2014 yield and cumulative yield as the sum of 2013 and 2014. Yield efficiency was calculated for 2014 and cumulatively utilizing trunk cross-sectional

Table 1. Trunk cross-sectional area, cumulative root sucker number, and zonal chlorosis of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial.[z]

Rootstock	Trunk cross-sectional area (2014, cm^2)	Tree height (2014, cm)	Canopy width (2014, cm)	Cumulative root suckers (2010-14, no.)	Zonal chlorosis (2014, % canopy affected)
B.9	6.3	238	128	4.8	24
B.10	10.4	281	175	0.0	24
B.7-3-150	18.1	344	194	0.9	20
B.7-20-21	17.3	306	185	2.8	48
B.64-194	21.3	366	200	0.0	16
B.67-5-32	19.6	337	182	1.2	21
B.70-6-8	19.9	348	188	0.5	20
B.70-20-20	34.7	388	245	8.8	12
B.71-7-22	2.0	143	71	3.2	57
G.11	8.7	290	190	8.4	33
G.41N	9.3	278	172	0.4	14
G.41TC	8.6	259	170	8.8	34
G.202N	19.8	353	232	24.5	24
G.202TC	12.6	292	215	14.8	38
G.935N	12.7	322	213	9.9	44
G.935TC	9.2	255	178	12.4	83
CG.2034	9.7	255	142	0.2	59
CG.3001	20.7	320	265	1.3	64
CG.4003	7.6	293	159	1.9	19
CG.4004	16.9	337	230	9.3	16
CG.4013	12.0	349	230	15.4	52
CG.4214	13.8	327	200	20.3	58
CG.4814	12.7	297	204	16.6	72
CG.5087	12.4	294	206	4.3	53
CG.5222	15.6	300	204	13.9	47
Supp.3	8.2	282	168	2.3	63
PiAu 9-90	16.0	282	178	0.0	81
PiAu 51-11	15.4	315	194	4.5	44
M.9 NAKBT337	10.0	290	175	10.2	33
M.9 Pajam 2	9.2	249	159	16.1	39
M.26 EMLA	9.8	282	185	7.7	30
HSD (*P = 0.05*)	7.6	74	56	19.3	45

[z] If two means in a column differ by more than the HSD, then they are significantly different at odds of 19 to1 (Tukey's HSD, P = 0.05).

area in October, 2014. Fruit size (weight) was calculated from total weight and number of fruit harvested per tree in both 2013 and 2014, so data presented here are for 2014 and the average weight of all fruit harvested in 2013 and 2014. Root suckers were counted and removed each year, so presented data are cumulative counts. Tree size (trunk cross-sectional area, tree height, and canopy width) was measured in October, 2014. Honeycrisp leaf yellowing (zonal chlorosis) was assessed after harvest in 2014 as the percent of the leaf canopy affected.

As an added assessment of the effect of rootstock on apple trees, each tree in the trial was rated subjectively as to its suitability for a Tall Spindle system, i.e. the "Clements Tall Spindle Index." The system utilized a scale from 0, indicating a tree poorly suited to tall spindle, to 3, indicating a tree excellently suited to tall spindle.

Table 2. Yield per tree, yield efficiency, and fruit weight in 2014 of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial.[z]

Rootstock	Yield per tree (2014, kg)	Cumulative yield per tree (2013-14, kg)	Yield efficiency (2014, kg/cm^2 TCA)	Cumulative yield efficiency (2013-14, kg/cm^2 TCA)	Fruit weight (2014, g)	Average fruit weight (2013-14, g)
B.9	6.3	13.4	1.05	2.10	240	229
B.10	7.0	22.8	0.71	2.20	247	215
B.7-3-150	9.9	20.8	0.56	1.17	281	256
B.7-20-21	8.5	25.7	0.45	1.46	219	224
B.64-194	5.6	21.4	0.25	0.94	244	228
B.67-5-32	5.8	18.2	0.31	0.97	248	234
B.70-6-8	7.9	25.2	0.40	1.28	242	233
B.70-20-20	6.2	23.4	0.18	0.67	257	236
B.71-7-22	1.2	2.9	0.64	1.58	164	179
G.11	14.1	28.8	1.60	3.30	269	246
G.41N	12.3	26.7	1.35	2.84	263	244
G.41TC	10.0	18.1	1.08	2.00	259	241
G.202N	12.2	50.3	1.10	2.54	239	246
G.202TC	13.2	34.0	1.03	2.69	218	205
G.935N	17.6	42.2	1.36	3.26	229	221
G.935TC	3.1	18.2	0.40	2.04	206	201
CG.2034	7.0	14.0	1.09	1.96	247	231
CG.3001	10.8	52.9	0.53	2.53	248	224
CG.4003	12.0	25.6	1.57	3.29	188	209
CG.4004	13.5	40.1	0.77	2.35	248	232
CG.4013	6.4	29.4	0.54	2.36	206	210
CG.4214	11.0	26.7	0.77	1.93	234	238
CG.4814	10.5	31.0	0.83	2.46	212	213
CG.5087	6.4	28.9	0.52	2.09	259	234
CG.5222	6.7	21.9	0.44	1.42	205	206
Supp.3	6.4	18.3	0.73	2.21	223	214
PiAu 9-90	0.7	9.7	0.06	0.56	125	129
PiAu 51-11	5.7	19.7	0.34	1.27	249	238
M.9 NAKBT337	13.6	24.3	1.35	2.41	242	235
M.9 Pajam 2	6.0	17.7	0.60	1.92	222	211
M.26 EMLA	9.4	18.5	0.94	1.88	226	221
HSD ($P = 0.05$)	10.4	17.5	0.88	1.1	88	57

[z] If two means in a column differ by more than the HSD, then they are significantly different at odds of 19 to1 (Tukey's HSD, $P = 0.05$).

Results

At the end of the 2014 growing season, largest trees were on B.70-20-20, and smallest trees were on B.71-7-22 (Table 1, Figure 1). The largest number of root suckers were produced (cumulatively, 2010-14) by G.202N (Table 1). The greatest portion of the canopy affected by Honeycrisp zonal chlorosis was for trees on G.935TC and PiAu 9-90, and the lowest amount was assessed for trees on B.70-20-20, B.64-5-32, CG.4004, and CG.4003 (Table 1).

In 2014, yield was greatest from trees on G.935N and least from trees on PiAu 9-90 (Table 2). Cumulatively (2013-14), greatest yields were harvested from trees on CG.3001, and lowest yields were from trees on B.71-7-22 (Table 2). The most yield efficient trees in 2014 and cumulatively (2013-14) were on G.11, and the least were on PiAu 9-90 (Table 2, Figure 2). The largest fruit in 2014 and on average (2013-14) were harvested in from trees on B.7-20-21, and the smallest were harvested from those on PiAu 9-90 (Table 2).

The Honeycrisp trees rated most suited for the Tall Spindle system were on G.935N, G.202N, and CG.4214 (Figure 3). Honeycrisp trees deemed least suited for Tall Spindle were on B.70-20-20, B.71-7-22, PiAu 9-90, B.64-194, CG.2034, and B.9.

Discussion

Honeycrisp, obviously, is a weak scion cultivar,

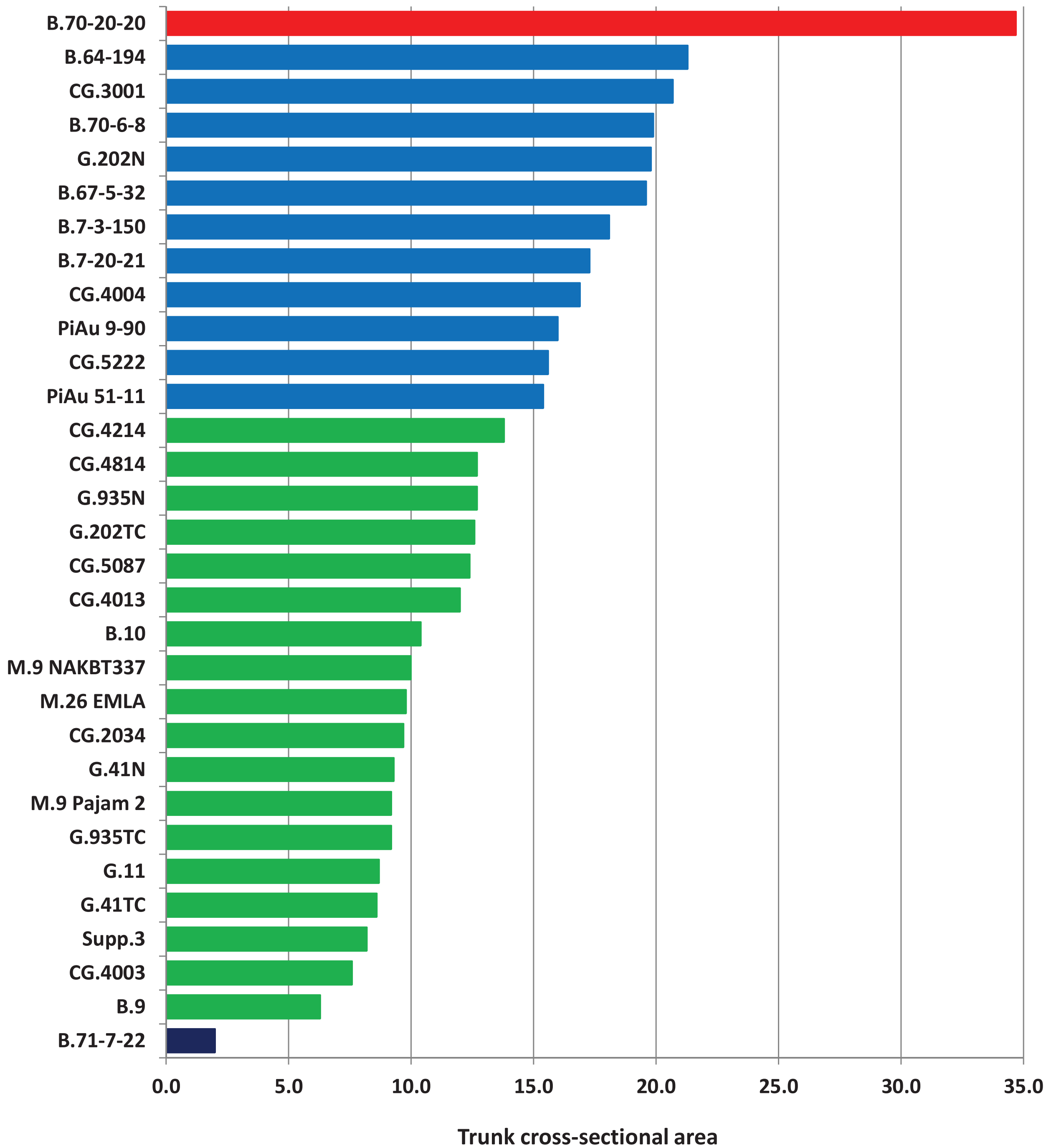

Figure 1. Tree size (trunk cross-sectional area) in 2014 of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial. Bar color: red -- standard size tree; blue -- semi-dwarf tree; green -- dwarf tree; dark blue -- subdwarf tree.

and optimal rootstocks for Honeycrisp, may be different than those for more vigorous scions. That said, it is interesting to look at the results in a bit more detail. First, the bars in Figure 1 are color coded, with one red bar representing the standard-sized B.70-20-20. This rootstock clearly is not suitable for modern planting, too vigorous even for Honeycrisp. Blue bars represent those rootstocks that could be considered semidwarf,

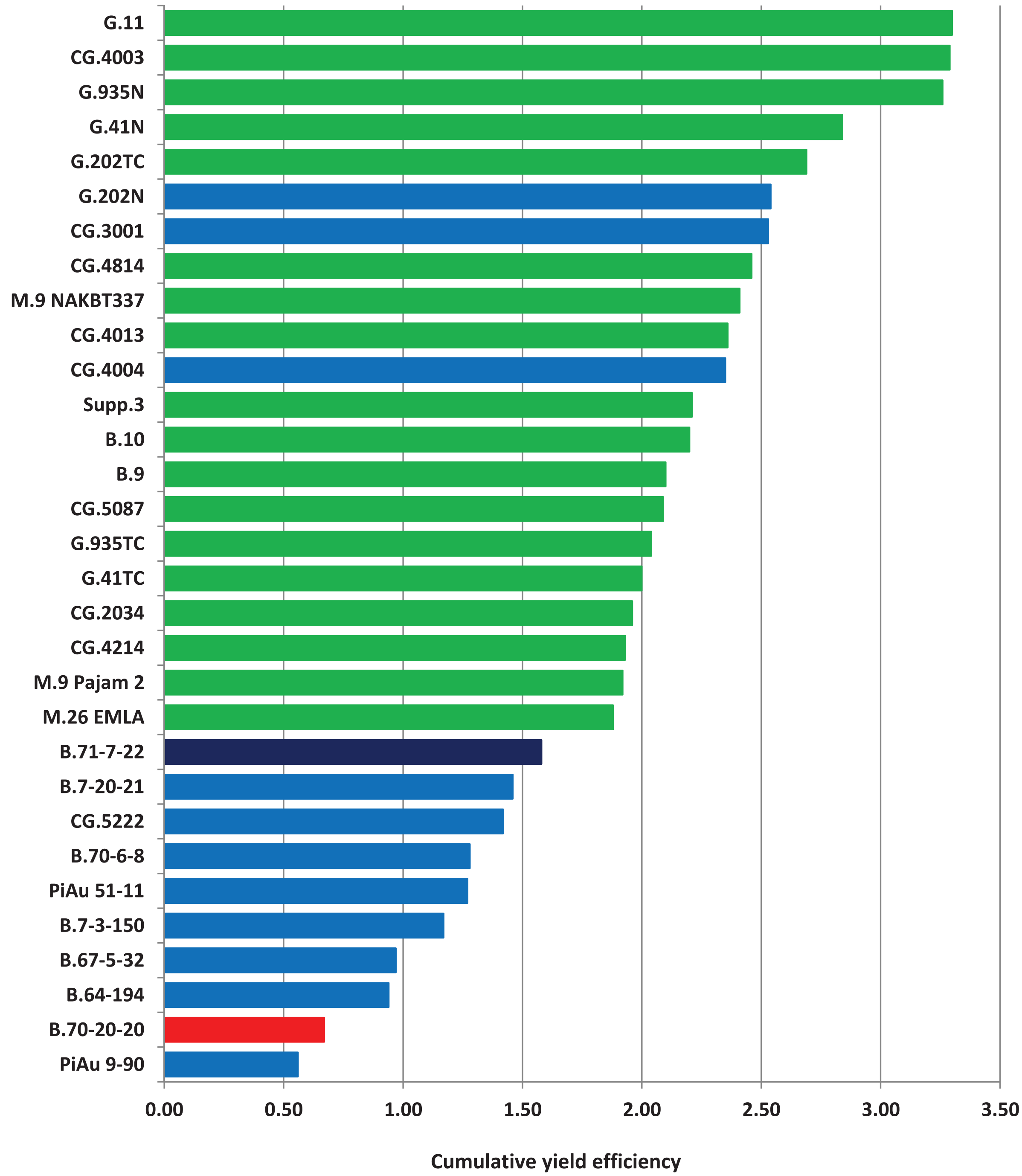

Figure 2. Cumulative yield efficiency (2013-14, yield per unit of trunk cross-sectional area) in 2014 of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial. Bar color: red -- standard size tree; blue -- semi-dwarf tree; green -- dwarf tree; dark blue -- subdwarf tree.

green representing dwarf rootstocks. Dark blue represents the subdwarf B.71-7-22, which also is likely unsuitable for modern planting because of the low vigor.

In Figure 2, rootstocks are arrayed from the most yield efficient at the top to the least at the bottom. Trends are as you would expect, for the most part. Dwarf trees tend to be more efficient than semidwarfs. Notable exceptions include the semidwarf G.202N,

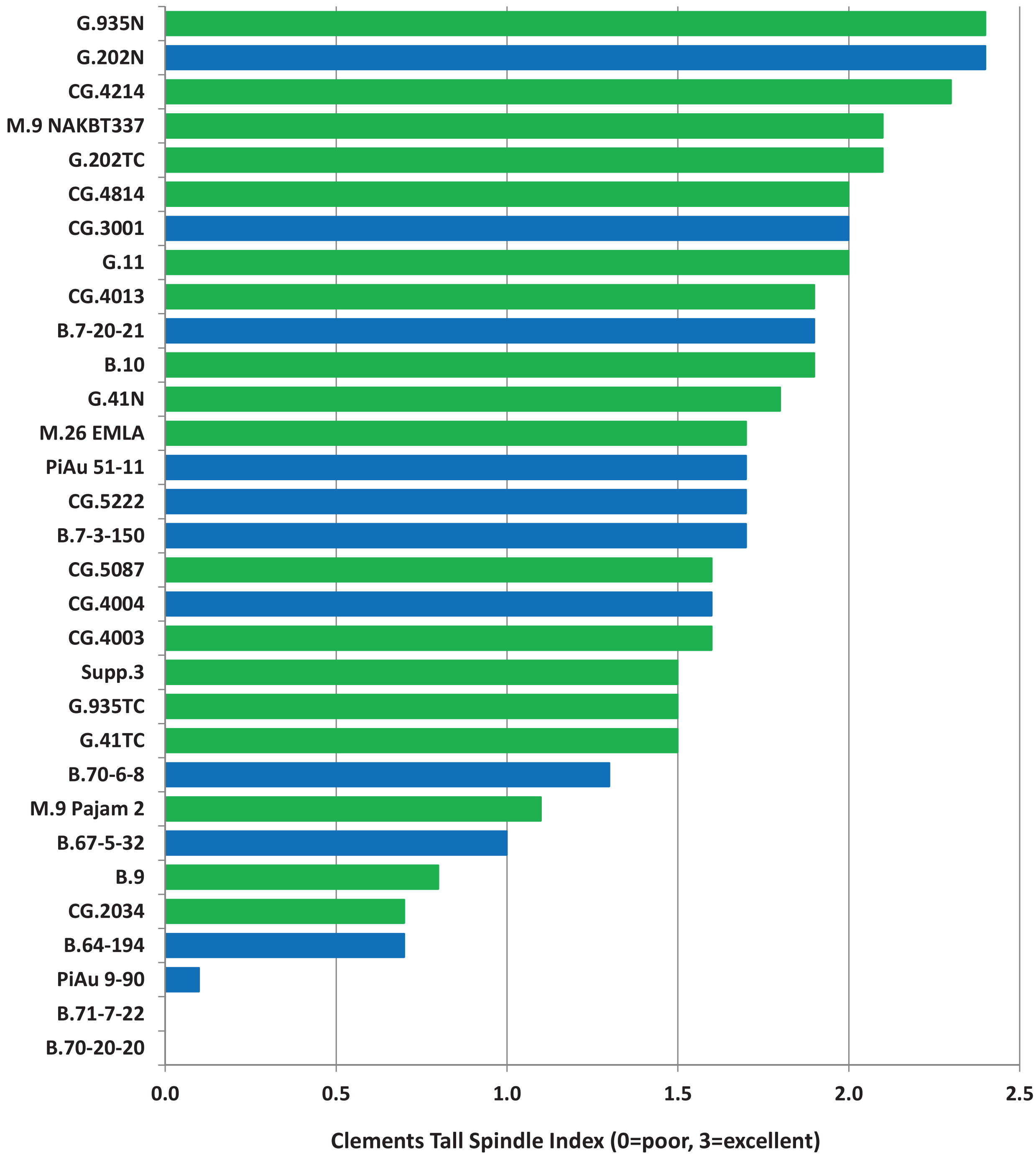

Figure 3. Horticultural rating (Clements Tall Spindle Index) in 2014 of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial. Bar color: red -- standard size tree; blue -- semi-dwarf tree; green -- dwarf tree; dark blue -- subdwarf tree.

CG.3001, and CG.4004. All three of these rootstocks produced semidwarf trees that were quite yield efficient. The subdwarf B.71-7-22 was relatively low in yield efficiency. B.70-20-20 had very low yield efficiency, but the substantially weaker rootstock PiAu 9-90 was even less efficient (numerically).

The Clements Tall Spindle Index is a subjective assessment of trees just prior to harvest. Jon individually rated each tree from 0 to 3. Being a subjective index, there was a lot of variability in the data, but some results are clear. The very large trees on B.70-20-20 and the very small ones on B.71-7-22 were poor for the Tall Spindle system. Likewise, PiAu 9-90 was rated as very poor. Other vigorous and weak rootstocks also rated as poor. Amongst the others, both dwarf and semidwarf trees were in the highest categories. G.935N and G.202N rated the best. G.935N was among the largest dwarfs and the most yield efficient trees. G.202N was the most yield efficient semidwarf and among the largest semidwarfs. The ability of G.202N to perform well in this trial likely is due to the low vigor of Honeycrisp.

This trial is our first rootstock evaluation planted to a Tall Spindle System, and it is very interesting to follow these trees with more competition and in what is closer to a real world situation. In the next few years, more separation among the rootstocks will occur, and we will be able to make better recommendations as to their future value. At this point, however, several Cornell-Geneva rootstocks are performing very well, and the most of the new Budagovsky rootstocks are not.


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