ANNUAL REPORT TO NC-140

Massachusetts
Agricultural Experiment Station

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2014 NC-140 Apple Rootstock Trial

This year was an "off" year for bearing in this trial. The crop was very disappointing, and in a commercial setting would have been barely worth harvesting. Apparently, these Honeycrisp trees were over-cropped in 2018. With the exception of V.1, the Vineland rootstocks continue to be quite large, and are not suitable for tall-spindle. The same could be said for G.890, although fruit yield in 2019 was more than any other rootstock, and cumulative yield, yield efficiency, and cumulative yield efficiency are high for this rootstock, and better than the Vineland rootstocks. G.30 and G.969 look very good to date, G.30 in particular. Anecdotal observation during harvest suggests that apples off G.969 were smaller and greener (particularly in 2018) than apples from trees on other rootstocks. Apples from trees on G.890 and G.30 have been very nice with good red color. Unfortunately, these two rootstocks also have the most root suckers. There seems to be something wrong with G.202 and M.9 trees in this planting, as they are underperforming (mostly in terms of tree size). G.214 may be a sleeper; it has performed well in this planting. Lastly, no apples were used for Terence Robinson's nutrient study this year, there simply were not enough fruit to meet the needs of the study protocol.

Table 1. Tree and yield characteristics in 2019 of Honeycrisp apple trees in the 2014 NC-140 Apple Rootstock Trial at the UMass Cold Spring Orchard Research & Education Center, Belchertown, MA.

Rootstock	Trunk cross-sectional area (2019, cm^2)	Cumulative root suckers (2015-19, no./tree)	Yield per tree (2019, kg)	Cumulative yield per tree (2015-19, kg)	Yield efficiency (2019, kg/cm^2 TCA)	Cumulative yield efficiency (2015-19, kg/cm^2 TCA)	Fruit weight (2019, g)
V.1	14.9 de	0.2 d	0.3 c	26.4 cd	0.02 b	2.67 bcd	232 abc
V.5	21.7 b	0.4 d	1.3 bc	29.2 c	0.06 ab	1.88 d	225 bc
V.6	23.9 ab	0.7 d	2.1 bc	31.2 bc	0.08 ab	1.80 d	238 abc
V.7	19.8 bc	2.0 cd	1.9 bc	27.5 cd	0.10 ab	1.89 cd	211 bc
G.11	9.6 fgh	0.9 d	1.7 bc	21.2 cde	0.17 ab	3.28 ab	249 abc
G.30	20.0 bc	8.8 ab	5.4 ab	49.0 a	0.28 a	4.05 a	253 abc
G.41	12.2 defgh	1.2 d	1.9 bc	22.1 cde	0.16 ab	2.73 bcd	266 ab
G.202	8.3 gh	0.3 d	0.8 c	11.8 e	0.07 ab	1.97 cd	264 abc
G.214	13.7 def	5.6 bc	1.0 c	30.3 c	0.07 ab	3.42 ab	213 bc
G.890	26.8 a	10.3 a	6.5 a	45.4 a	0.24 ab	2.55 bcd	286 a
G.935	11.5 efgh	3.5 cd	1.0 bc	23.8 cd	0.09 ab	2.89 bcd	248 abc
G.969	16.0 cd	1.5 cd	1.8 bc	41.6 ab	0.11 ab	4.07 a	227 bc
M.9 NAKBT337	7.8 h	1.9 cd	0.7 c	18.5 de	0.08 ab	3.08 abc	195 c
M.26 EMLA	12.5 defg	1.9 cd	2.4 bc	21.1 cde	0.21 ab	2.57 bcd	212 bc

Mean separation within columns by Tukey's HSD (*P=0.05*).

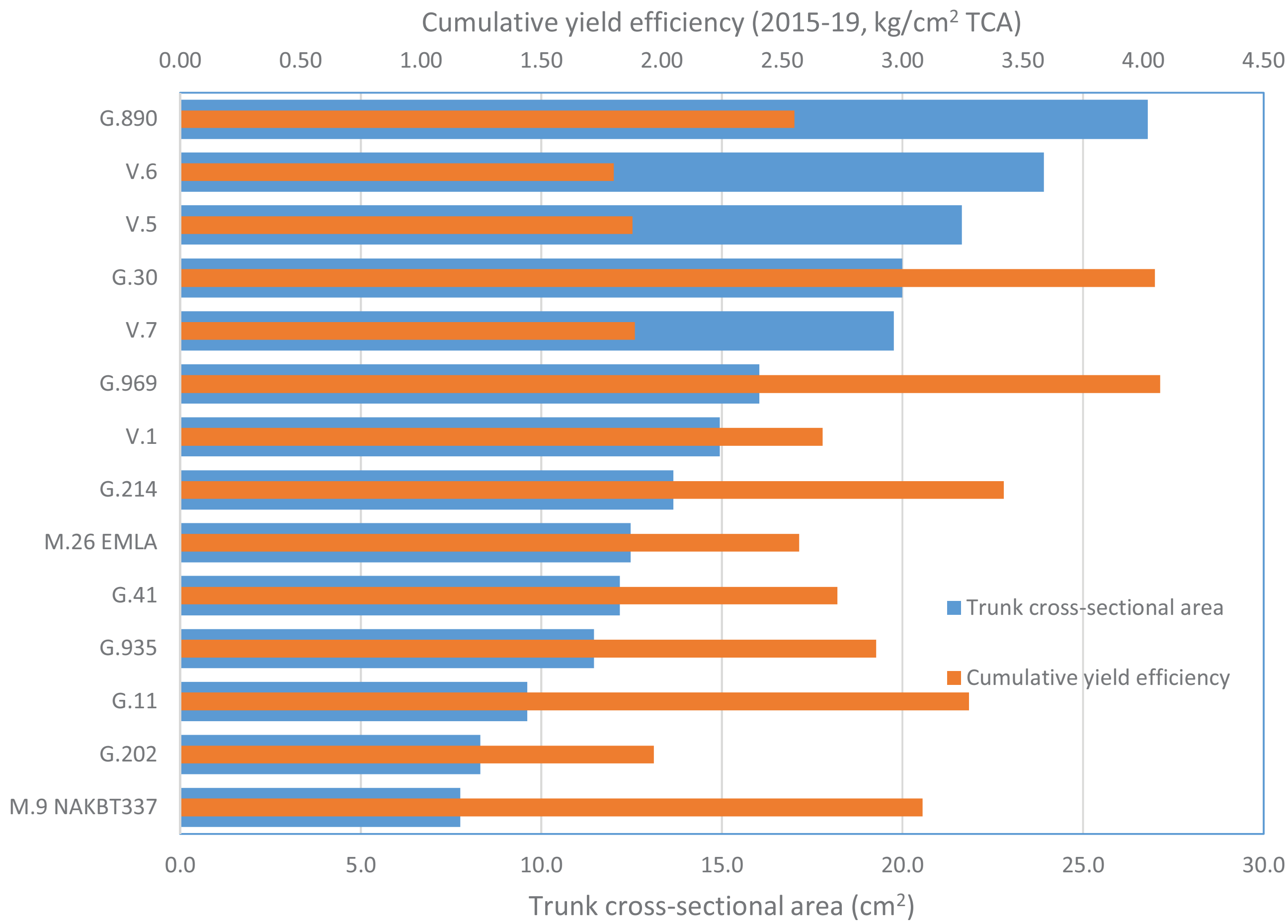

Figure 1. Trunk cross-sectional area (cm^2) and cumulative yield efficiency (2015-19, kg/cm^2 TCA) in 2018

2015 NC-140 Organic Apple Rootstock Trial

This rootstock planting in a commercial "Certified Naturally Grown" orchard gets more disappointing every year. More trees are dying or failing, and fruit quality and yield in 2019 was poor. It is unclear if low fruit set and yields are a result of pollination issues or the "organic" management regimen? In 2018, there were virtually no apples, and the entire rest of the orchard was light too. In 2019, the orchard had a good crop, but these Modi trees had a light to moderate crop. Another problem was the amount of insect damage, mostly plum curculio and internal Lepidopteran worms (codling moth or Oriental fruit moth) which made the apples quite deformed and small in size. Weed control and fertilization remain issues. The take home to date is that G.890, because of its vigor, is a good choice for organic orchards. Although G.30, G.202, and G.41 are acceptable also. G.16 is not right in this planting, and M.9 has really under-performed. G.935 has some issues, and we are wondering if it is the virus/rootstock/scion interaction. Liberty trees on G.935 planted between replications and as guard trees have all died. Marssonina leaf spot was confirmed in September, and has been causing early defoliation of these Modi trees.

In 2019 a Drapenet was installed over replications 1-6 (and not 7-12) the primary objective being to see if insect damage could be reduced. (Although there was a lot of hail around in 2019.) The Drapenet was installed on May 19 during late bloom, and was secured to the bottom wire with plastic wire ties. Inspection of the apples in late June showed that it was pretty much wholly ineffective at preventing plum curculio damage; however, a more formal harvest

Table 2. Tree and yield characteristics in 2019 of Modi apple trees in the 2015 NC-140 Organic Apple Rootstock Trial at the Small Ones Farm, Amherst, MA. All values are least-squares means adjusted for missing data.

Rootstock	Trunk cross-sectional area (2019, cm^2)	Tree height (m)	Canopy spread (m)	Yield per tree (2019, kg)	Cumulative yield per tree (2016-19, kg)	Yield efficiency (2019, kg/cm^2)	Cumulative yield efficiency (2016-19, kg/cm^2)	Fruit weight (2019, g)
G.11	6.3 cdef	2.7 bc	1.5 bc	0.7 abc	1.4 abc	0.11 a	0.30 ab	102 a
G.16	3.5 f	2.4 c	1.1 cd	0.4 bc	0.5 c	0.11 a	0.17 b	94 a
G.30	8.5 bc	2.9 b	1.5 bc	0.8 abc	1.9 abc	0.09 a	0.38 ab	111 a
G.41	8.0 bcd	2.7 bc	1.3 bcd	0.6 bc	1.8 abc	0.07 a	0.32 ab	115 a
G.202	9.5 b	2.7 bc	1.5 b	0.5 bc	1.7 abc	0.05 a	0.27 b	114 a
G.214	6.9 cde	2.9 b	1.4 bc	1.0 ab	1.8 abc	0.14 a	0.36 ab	97 a
G.222	4.5 ef	2.5 bc	1.1 cd	0.3 bc	1.1 abc	0.09 a	0.41 ab	102 a
G.890	14.1 a	3.3 a	2.0 a	1.3 a	2.3 ab	0.09 a	0.23 b	119 a
G.935	5.6 def	2.4 c	1.2 bcd	0.4 bc	1.9 abc	0.06 a	0.44 ab	109 a
G.969	6.4 cde	2.7 bc	1.3 bcd	0.7 abc	2.4 a	0.11 a	0.56 a	104 a
M.9 NAKBT337	4.6 ef	2.4 c	1.0 d	0.2 c	0.7 bc	0.04 a	0.22 b	101 a

Mean separation within columns by Tukey's HSD (*P=0.05*).

survey of 100 fruit per treatment (covered with Drapenet vs. uncovered) for damage showed that internal worms, most likely caused by codling moth or Oriental fruit moth, were greater in the uncovered (35%) vs. covered (12%) replications. But, as already mentioned, plum curculio damage was greater in covered (80%) vs. uncovered (51%). Interestingly, the incidence of apple maggot fly injury was also greater in the covered (26%) vs. uncovered (5%) apples. Sooty blotch and flyspeck were also greater in the Drapenet apples (59% for sooty blotch, 21% for flyspeck) than the uncovered apples (19% and 12%, respectively, for sooty blotch and flyspeck). These results are investigatory, as the covered vs. uncovered was not randomized and replicated for statistical analysis.

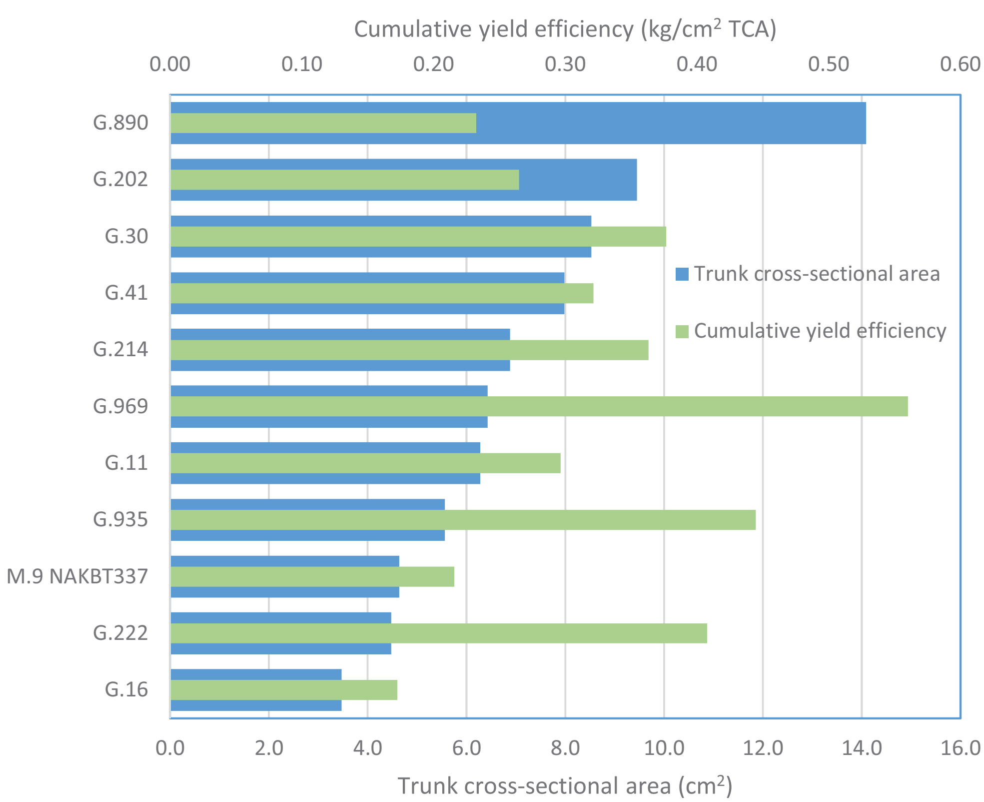

Figure 2. Trunk cross-sectional area (cm^2) and cumulative yield efficiency (2017-19, kg/cm^2 TCA) in 2019 of Modi apple trees in the 2015 NC-140 Organic Apple Rootstock Trial.

2010 NC-140 Honeycrisp Rootstock Trial -- Nutrient Study

In collaboration with Cornell University and Terence Robinson, a total of 60 apples were harvested off selected Geneva rootstocks and commercial standards (total 19 rootstocks, 4 replications) from the 2010 NC-140 Honeycrisp Rootstock Trial in 2019. (Which has otherwise been discontinued.) Ten apples from each rootstock by replication were peeled and the peel sent to Cornell for nutrient analysis per the supplied protocol. The other 50 apples were put in cold storage at 3.3C. at the UMass Orchard and will be evaluated for bitter pit after 90 days in storage. Bitter pit incidence was also noted at harvest. This is the second year of this cooperative study with Cornell to look at rootstock effect on fruit nutrient content and bitter pit development.

Accomplishments Related to Objective 1:

2014 NC-140 Apple: Trees generally grew well in 2019 (sixth leaf), but yield was low. Largest trees were on G.890 and V.6, and smallest were on G.41, G.935, G.11, G.202, and M.9 NAKBT337. Because of the measured vigor, it is clear that trees labeled as being on G.202 are actually on some other rootstock. Cumulatively (2015-19), the greatest yields per tree were from trees on G.30, G.890, and G.969, and the lowest were from those on G.202, M.9 NAKBT337, M.26 EMLA, G.11, and G.41. Cumulatively (2015-19), the most yield efficient trees were on G.969, G.30, G.214, G.11, and M.9 NAKBT337, and the least were on V.6, V.5, V.7, and G.202. The largest fruit in 2019 were harvested from trees on G.890, and the smallest were from trees on M.9 NAKBT337.

2015 NC-140 Organic Apple: Trees in this trial continue to be challenged and unproductive. After five growing seasons, largest trees were on G.890, and the smallest were on G.16, G.222 and M.9 NAKBT337. Cumulatively (2016-19), the greatest yields per tree were harvested from trees on G.969, and the lowest were harvested from trees on G.16. Cumulatively (2016-19), the most yield efficient trees were on G.969, and the least were on G.16, M.9 NAKBT337, G.890, and G.202. No differences in fruit size as affected by rootstock were measured in 2019.

Impact Statements:

Planting of 150 acres of trees on dwarfing rootstock occurred during 2019 based on results of NC-140. On this acreage, pruning and harvest labor declined by 50%, fruit quality and size increased by 20%, profit increased by 50%, and because of reduced canopy volume, pesticide use declined by 70%.

Published Written Works:

Reighard, GL, W Bridges Jr., D Archbold, A Atucha, W Autio, T Beckman, B Black, D Chavez, E Coneva, K Day, M Kushad, RS Johnson, T Lindstrom, J. Lordan, I Minas, D Oulette, ML Parker, R Pokharel, TL Robinson, J Schupp, M Warmund, and D Wolfe. 2018. Rootstock performance in the 2009 NC-140 Peach Trial across 11 states. Acta Hortic. 1228:181-186. https://doi.org/10.17660/ActaHortic.2018.1228.27.

Muehlbauer, M., W. Cowgill, J. Clements, and W. Autio. 2019. Update on the 2014 NC-140 Honeycrisp and Aztec Fuji rootstock trials in New Jersey and Massachusetts. Fruit Notes 84(2):15-18. Horticultural News 99(2):15-18. http://www.umassfruitnotes.com/v84n2/a3.pdf http://www.horticulturalnews.org/99-2/a3.pdf

Reighard, GL, W Bridges Jr., D Archbold, A Atucha, W Autio, T Beckman, B Black, D Chavez, E Coneva, K Day, M Kushad, RS Johnson, T Lindstrom, J. Lordan, I Minas, D Oulette, ML Parker, R Pokharel, TL Robinson, J Schupp, M Warmund, and D Wolfe. 2020. Nine-year rootstock performance of the NC-140 Redhaven Peach Trial across 13 states. J. Amer. Pomol. Soc. ACCEPTED FOR PUBLICATION.

Autio, W, T Robinson, B. Black, R Crassweller, E Fallahi, M Parker, R Parra Quezada, G Reig, and D Wolfe. 2020. Budagovsky, Geneva, Pillnitz, and Malling apple rootstocks affect 'Fuji' performance over eight years in the 2010 NC-140 "Fuji' Apple Rootstock Trial. J. Amer. Pomol. Soc. IN PREPARATION.

Autio, W, T Robinson, S. Blatt, D Cochran, P. Francescato, E Hoover, M Kushad, G Lang, J Lordan, D Miller, I Minas, R Parra Quezada, M Stasiak, and H Xu. 2020. Budagovsky, Geneva, Pillnitz, and Malling apple rootstocks affect 'Honeycrisp' performance over eight years in the 2010 NC-140 "Honeycrisp' Apple Rootstock Trial. J. Amer. Pomol. Soc. IN PREPARATION.

Scientific and Outreach Oral Presentations:

Autio, WR Update on NC-140 Rootstock Research. January 10, 2019. Massachusetts Fruit Growers' Association Annual Meeting. Fitchburg, MA. Attendance: 100.

Fund Leveraging:

Autio, W, J Cline, I Minas, G Lang, and T Einhorn. 2019. NC-140 Rootstock Research Trial Coordinators. International Fruit Tree Association. $12,000.