2020 Update on NC-140 Fuji and Honeycrisp Apple Rootstock Trials in New Jersey

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Over the past 40+ years the NC-140 Regional Rootstock Project has leveraged the support and resources of both Universities and tree fruit experts from around the country to trial novel rootstocks to continue to propel North American tree fruit production into the future. Optimal rootstock choice aids greatly in maximizing vigor, yield, disease and insect resistance for tree fruit orchards. However, environmental factors, diseases and insects change with time. Thus, it is critical to maintain trials to test for these evolving challenges. As well as to establish new trials of rootstocks from breeding programs around the world.

Overview of Trials

The Rutgers Snyder Research and Extension Farm in Pittstown, NJ is currently host to a number of NC-140 trials including the 2014 Fuji and Honeycrisp rootstock trials. The Honeycrisp trial was planted in 2014 at a spacing of 4' x 12' (907 trees per acre), and the Fuji trial is planted at 5' x 13' (672 trees/acre). The trees have been maintained according to commercial standards as described in the New Jersey Tree Fruit Production Guide. Both were planted and trained to the Tall Spindle Production system, the standard for the fresh market apple industry.

The Honeycrisp planting consists of 14 rootstocks (B.10, G.11, G.202, G.214, G.30, G.41, G.935, G.969, M.26 EMLA, M.9 NAKBT337, V.1, V.5, V.6, and V.7). While the Fuji planting consists of only 11 rootstocks (G.11, G.202, G.214, G.30, G.935, M.9 NAKBT337, M.26 EMLA, V.1, V.5, V.6, and V.7).

Data from each planting is collected at harvest. This includes total yield per tree, vigor (as assessed by trunk cross-sectional area, TCA), and number of fruit per tree. These data are used to extrapolate average fruit weight and average yield efficiency for each rootstock.

2020 Growing Season

The 2020 growing season had a rough start in Northern New Jersey. In Mid-March due to Covid, much of the state was shutdown. Rutgers University implemented a hiring freeze that impacted all research at outlying field stations and lead to delays in pruning the NC140 trials. Growers in the Northern Part of the state had 9 different cold and freeze events during our apple bloom period. Luckily, there was little to no damage of the apple crop at the Rutgers Snyder Research Farm in Pittstown, NJ. The remaining season was fairly normal with no notable temperature swings, droughts or floods. Interestingly, very little bitter rot or bitterpit was observed in the trials for the 2020 growing season.

Yield and Vigor for 2020, Honeycrisp

Honeycrisp fruit were harvested on September 14, 2020. Average yields were highest on the V.5 rootstocks (54.6 lb./tree), this rootstock also produced the largest number of fruit per tree (104 fruit/tree). Average yields were found to be the lowest on G.202 (12.8 lb./tree), this rootstock also yielded the lowest number of fruit per tree (20 fruit/tree). The average TCA was highest for V.6 (7.4 in^2), and lowest for G.202 (2.4 in^2). Average yield efficiency was found to be the highest for G.969 (15.8 $lb./in^2$) followed by G.935 with lowest for G.202 (5.5 $lb./in^2$) (Table 1). There was no statistical difference in the number of suckers (Table 1).

Yield and Vigor for 2020, Fuji

Fuji fruit were harvested on November 2, 2020. Average yields were highest on V.6 rootstocks (71.2 lb./tree); however, the greatest number of apples were found on G.30 rootstocks (123 fruit/tree). G.214 were the lowest yielding rootstocks (26.8 lb./tree), and also had the lowest number of fruit per tree (43 fruit/tree). The average TCA was highest for V.6 (8.9 in^2), and lowest for G.202 (4.8 in^2). The highest average yield efficiency was found to be G.30 (9.7 lbs/in^2) and the lowest on M.26 EMLA (5.7 lbs/in^2). This was similar to the 2019 growing season where the highest yield

Table 1. Yield and tree vigor data for 14 rootstocks included in the 2014 NC-140 Honeycrisp Rootstock Trial located at the Snyder Research and Extension Farm in Pittstown, NJ.

Rootstock	Trunk cross-sectional area (in^2)	Yield (no. fruit/tree)	Fruit weight (oz)	Root suckers (no./tree)	Yield (lbs/tree)	Yield efficiency (lbs/in^2)
G.202	2.4 e	20 b	10.9 a	0 a	12.8 c	5.5 b
G.11	2.5 e	28 b	13.0 a	0 a	18.1 bc	7.9 ab
B.10	3.1 de	29 b	9.4 a	0 a	16.9 bc	5.7 b
G.41	3.2 de	36 b	9.6 a	0 a	22.5 abc	7.1 ab
G.214	3.3 de	58 ab	9.3 a	1 a	31.2 abc	9.6 ab
M.9 NAKBT337	3.4 de	51 b	9.4 a	2 a	27.8 abc	8.7 ab
G.935	3.6 de	82 ab	9.3 a	4 a	43.1 abc	12.0 ab
M.26 EMLA	4.1 cde	43 b	11.8 a	7 a	24.6 abc	6.5 b
G.969	4.6 cde	146 a	7.2 a	4 a	63.5 a	15.8 a
G.30	5.5 bc	52 b	10.6 a	4 a	31.5 abc	7.1 ab
V.1	6.0 ab	70 ab	9.9 a	3 a	41.8 abc	7.0 ab
V.7	6.1 ab	97 ab	8.2 a	1 a	49.6 abc	8.8 ab
V.5	6.3 ab	104 ab	9.4 a	0 a	58.5 ab	9.4 ab
V.6	7.4 a	80 ab	11.2 a	0 a	54.6 abc	7.0 ab

Means not followed by a common letter are different at odds of 20:1 (Tukey's HSD, *P*=0.05).

Table 2. Yield and tree vigor data for 11 rootstocks included in the 2014 NC-140 Fuji Rootstock Trial located at the Snyder Research and Extension Farm in Pittstown, NJ.

Rootstock	Trunk cross-sectional area (in^2)	Yield (no. fruit/tree)	Fruit weight (oz)	Root suckers (no./tree)	Yield (lbs/tree)	Yield efficiency (lbs/in^2)
G.202	4.8 b	59 a	9.1 a	1 a	32.7 a	7.5 a
G.214	5.5 b	43 a	9.9 a	0 a	26.8 a	5.9 a
G.11	5.6 ab	76 a	9.7 a	0 a	45.4 a	8.3 a
G.935	5.8 ab	69 a	9.8 a	0 a	38.9 a	6.6 a
M.9 NAKBT337	5.9 ab	62 a	9.1 a	1 a	34.9 a	6.0 a
M.26 EMLA	7.3 ab	58 a	10.1 a	1 a	34.4 a	5.7 a
V.1	7.5 ab	87 a	8.6 a	0 a	45.6 a	6.0 a
G.30	7.7 ab	123 a	8.5 a	1 a	66.5 a	9.7 a
V.5	8.7 a	69 a	9.1 a	0 a	38.9 a	5.0 a
V.7	8.9 a	114 a	9.0 a	0 a	61.4 a	7.0 a
V.6	8.9 a	122 a	9.6 a	1 a	71.2 a	8.0 a

Means not followed by a common letter are different at odds of 20:1 (Tukey's HSD, *P*=0.05).

efficiency was also found to be G.30, although the lowest was found to be M.9 NAKBT337 (Muehlbauer et al. 2020). All rootstocks produced fewer than 2 root suckers per tree, and there was no statistical difference in the number of suckers by rootstock (Table 2).

Average fruit weight, average yield per tree, and average yield efficiency were not significantly different among rootstocks.

Comparison of Honeycrisp and Fuji

In comparing the Fuji and Honeycrisp yields (Figure 1), they differed in which rootstock produced the greatest yields (Fuji/V.7 and Honeycrisp/V.6). Interestingly, in 2019, both Fuji and Honeycrisp produced their greatest yields on V.7 (Muehlbauer et al. 2020). Similarly, in 2020, they differed on the root-

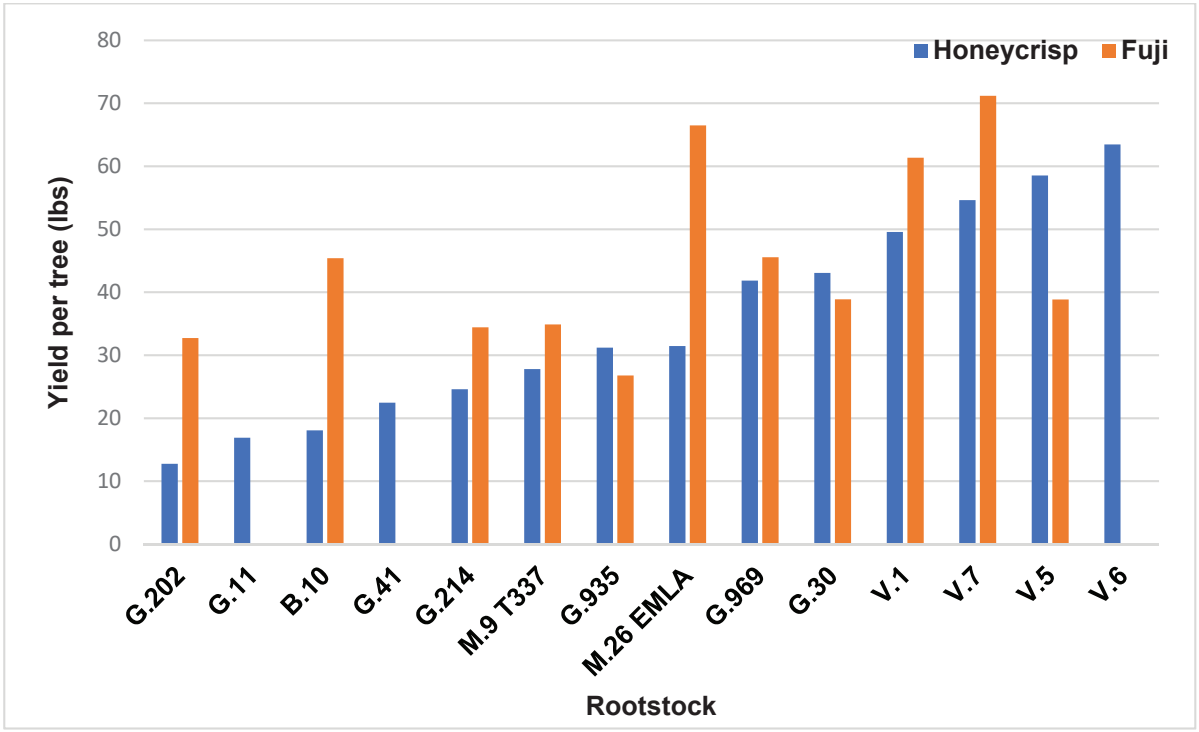

Figure 1. Yield per tree in 2020 for Honeycrisp and Fuji trees in the 2014 NC-140 Apple Rootstock Trials at the Rutgers Snyder Research and Extension Farm, Pittstown, NJ.

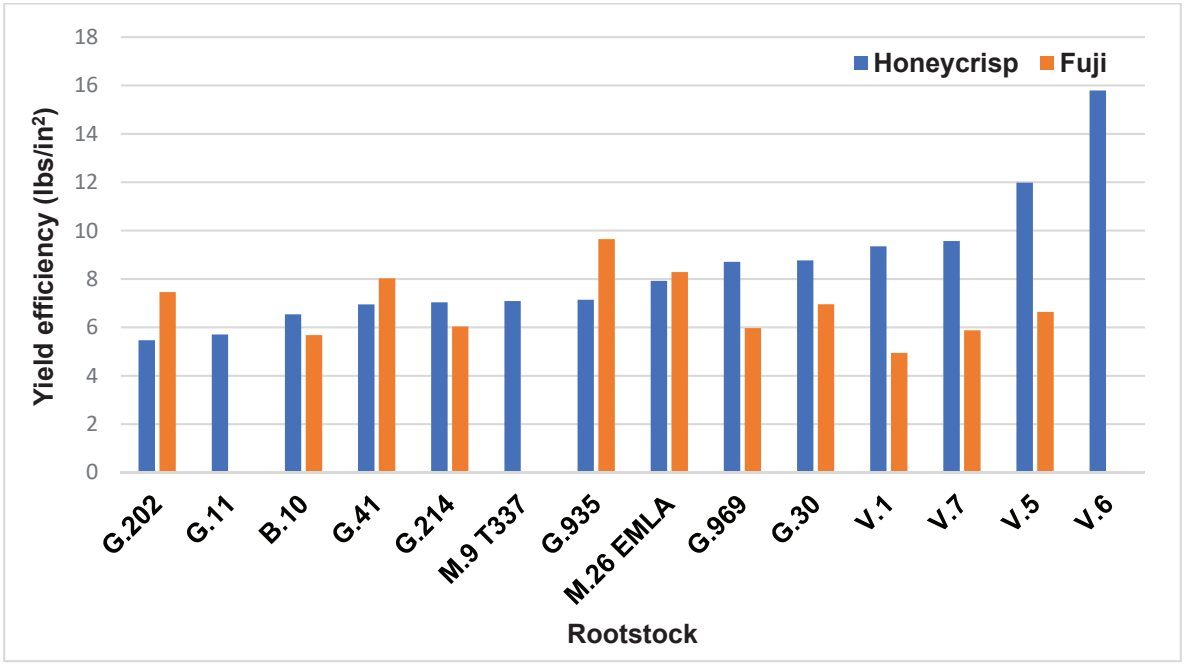

Figure 2. Yield efficiency (yield/TCA) in 2020 for Honeycrisp and Fuji 2014 NC-140 Apple Rootstock Tria at the Rutgers Snyder Research and Extension Farm, Pittstown, NJ.

stock that produced the lowest yields (Fuji/G.935 and Honeycrisp/G.202). However, again in 2019, both Fuji and Honeycrisp produced their lowest yields on G 202 (Figure 1) (Muehlbauer et al. 2020).

In comparing Honeycrisp and Fuji yield efficiency (Figure 2), the rootstock with the highest yield efficiency for Fuji and Honeycrisp differed (Fuji/V.6 and Honeycrisp/G.969). This differed from the 2019

growing season where Fuji had the highest yield efficiency on G.30, although it was followed closely by V.6, and Honeycrisp/M.9 NAKBT337 were the most efficient. The lowest yield efficiency also different between Fuji and Honeycrisp, Fuji/M.26 EMLA and Honeycrisp/G.202 for the 2020 growing season. This differed slightly from 2019 where the lowest yield efficiencies were found on Fuji/M.9 NAKBT337 and Honeycrisp/G.41. (Muehlbauer et al. 2020)

Conclusions

The Vineland (V.1, V.5, V.6, and V.7) series rootstocks we tested and M.26 EMLA, G.30 continue to show significant vigor in both the 2014 Fuji and Honeycrisp NC-140 rootstock trials. In particular, V.6 had the greatest TCA for both Fuji and Honeycrisp scions. The Vineland rootstocks tested with Fuji were too vigorous for a tall spindle system. None of the Vineland rootstocks, M.26 EMLA, or G. 30 look good in tall spindle with Fuji. Establishing this trial at 3' x 12' instead of 5' x 13' would have increased competition between trees and may have improved performance in a tall spindle system. However, at the established 5' x 13'spacing, the average fruit weight, average yield per tree, and average yield efficiency was not significantly different among rootstocks, and none were stellar performers.

Note that G.30 is a rootstock that has been evaluated in numerous NC-140 and other rootstock trials over the years. It fell out of favor with our US nurserymen as it is hard to propagate so there are very few stoolbeds of G.30 and therefore limited production.

The biggest conclusion from the NC-140 2014 Honeycrisp Trial is that G.969 and G.935 significantly outperformed the other stocks in yield efficiency and should be considered as rootstocks for Honeycrisp planted in a tall spindle system at 3' x 12' spacing.

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