What Are the Best Dwarfing Rootstocks for HoneyCrisp Apple, with Bitter Pit in Mind

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Honeycrisp apple has many challenges in growing it under commercial conditions, but one of the most difficult is the physiological disorder, bitter pit. Honeycrisp and some other varieties are very susceptible to this calcium deficiency disorder.

Bitter pit is a physiological disorder found in apple fruit. This is due to a lack of calcium in fruit cell walls which causes pitting of the fruit observed as discrete necrotic spots. This disorder can be particularly devastating in the high value cultivar Honeycrisp and can lead to 20-80% crop loss at harvest and/or after cold storage, see figures 1, 2.

Figure 1. Photo Credit: Fruitgrowernews.com

Figure 2. Left: Healthy apples no bitter pit. Right: Honeycrisp apples with bitter pit. Photo credit: researchgate.net.

The causes of bitter pit remain complex. It differs in severity based upon variety, calcium availability, summer temperatures, amount of shoot growth, and crop load. Managing these many factors takes very close observation, and sometimes costly mitigation strategies. One of which is monthly sprays of calcium, which have been shown to have inconsistent control of the disorder.

Rootstock Selection

The discussions in this article will focus on dwarfing rootstocks for Tall Spindle Planting Systems.

B.9 has been the rootstock of choice in the western New York apple growing region for reduced bitter pit in Honeycrisp for the past 15 plus years. It produces one of the smallest trees. We know this from past research, personal observation, and industry planting trends. However, note when B.9 is grown south of Lake Ontario it is more difficult to manage. This is true for even the Hudson Valley of NY. Also for NJ, VA and PA. In these states, B.9 tends to runt out in the warmer climates. B.9 is highly precocious as is HoneyCrisp, the combination causes

trees to stop growing after they begin to crop, hence the term runt out. We need a rootstock about the size of M.9-337 that will impart bitter pit tolerance to the Honeycrisp variety grown in Tall Spindle.

NC-140 Rootstock Multistate Trials

To this end our NC140- our multistate rootstock project has been investigating different rootstocks for size control and their effect on bitter pit, especially on vulnerable varieties such as Honeycrisp. Evidence has shown that rootstocks have differing vigor and differing abilities to update nutrients specifically cations (K and Ca), resulting in less bitter pit incidence found in certain cultivars. However, rootstock vigor, growth can differ based on environment. Thus, over the course of 3 years we collected data on bitter pit incidence in two rootstock studies (2010 & 2014 NC140 plantings) at the Rutgers Snyder Research and Extension Farm in Pittstown NJ to determine the effect of rootstock on bitter pit incidence in different Honeycrisp scion combinations.

We also looked at NC140 data from two other states, Virginia Polytech (VPI) and Cornell University.
At the Rutgers Snyder Farm:

- In NJ 2010 NC140 Rootstock trial B9 and B10 were equally good for controlling bitter pit at harvest, data not shown
- In NJ 2014 NC140 Rootstock trial B9 was not included.
- In NJ 2014 NC140 Rootstock trial, yield in pounds per tree was not significantly different between G.214, B10 and G.969 and were in line with all other rootstocks in this trial, Table 1.

Materials and Methods for NJ NC140 2013 HoneyCrisp Rootstock Planting

These trials were planted at these 3 locations above. Here were the parameters of the NJ, 2013 NC140 Honeycrisp trail. It was planted at a spacing of 4' by 12' (907 trees per acre) and consisted of 14 different 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, V.7). From 2014 to present the trees were managed in accordance with the commercial standards as written in the 2021/2022 New Jersey Tree Fruit Production Guide.

The trial was sampled during each of the following harvest seasons 2018, 2019, 2020. A total of 5 trees were sampled from each rootstock in the trial. At harvest a total of 50 random fruits were harvested from each tree. Each apple was rated for incidence of bitter pit and a total percentage of bitter pit (# of apples with bitter pit / 50 x 100) was recorded per tree. The samples were then loaded into bins and put into cold storage (37.4 °F) for 3 months. After three months the percent bitter pit incidence for each sample was recorded again.

Yield was recorded by tree and as well as the Trunk Cross Sectional Area to determine relative tree size in all 3 states. See Figure 3 and Table 1.

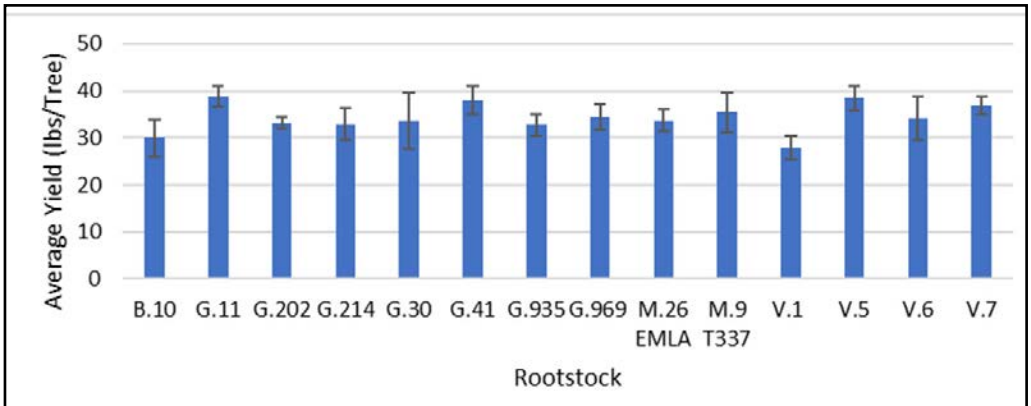


Figure 3. Average percentage yield of Honeycrisp apples 2018-2020 by tree across 14 rootstocks in the 2014 NC-140 Honeycrisp block, Rutgers Snyder Research and Extension Farm, Pittstown, Hunterdon County, NJ. Note: Data displayed with standard error bars.

Discussion

Budagovsky rootstocks, referred to as Bud or B. (e.g., B.9 and B.10), were developed in the Soviet Union by crossing M.8 x Red Standard (Krasnij Standart). B.10 was developed at the Michurinsk University of Agriculture, Russia, from crossing B.9 X B.13-14.

Dr. Sheriff noted "it is worth mentioning that B.9 and B.10 share the same breeding origins, and the resistance

Table 1. The size of 'HoneyCrisp' trees on different rootstocks relative to M.9 T337 and M.26 EMLA.

Rootstocks	Tree vigor relative to M.9 T337	Tree vigor relative to M.26 EMLA
G.41	0.93	0.80
G.11	0.94	0.81
G.935	1.08	0.92
B.10	0.88	0.76
M.9 T337	1.00	0.86
G.214	1.49	1.28
G.969	1.65	1.42
G.30	1.87	1.60
V.1	1.93	1.66
V.5	2.10	1.80
V.7	1.96	1.69
V.6	2.30	1.98

of B.9 to bitter pit cannot be called into question."

All three states -NJ, NJ, VA indicated B.10 is about the same size as M.9 T337. With G.214 and G.969 larger. See Figure 3 and Table 1 and refer to the Geneva Apple Rootstock Comparison Chart in the appendix.

In NJ, Figure 4 shows that rootstocks B.10, G.214 and G.969 had the lowest amount of bitter pit at harvest.

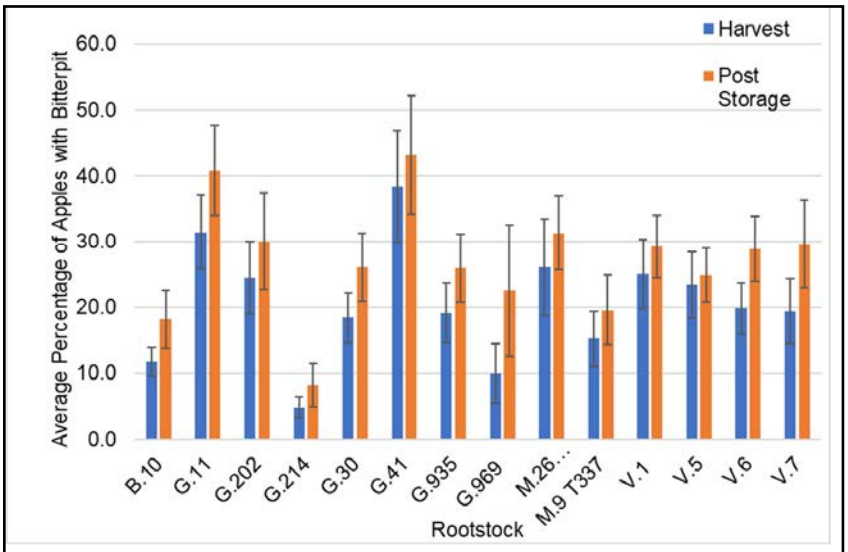


Figure 4. Rutgers NC140 Honeycrisp percentage of apples with bitter pit, data from 2018-2020 growing seasons.

In Virginia, VPI- Figure 5 shows B.10 had the lowest incidence of bitter pit.

In NY, Dr. Terence Robinsons data (not shown) indicates the 2014 NC140 average bitter pit incidence (%) of 15 rootstocks between 2018 and 2022 matched NJ results. That is in NY, B.10, G.969, and G.214 stocks had the lowest bitter pit incidence of the 15 over 5 years. All three of these stocks had low to moderate vigor measured by 5-year average TCSA increment measurement. Of the three in the period of 2018-2022, G.969 had the highest 5-year cumulative yield and the bitter pit free yield was nearly identical to the cumulative yield. Both B.10 and G.969 had high average fruit peel calcium (Ca) and low fruit peel K/Ca between the years of 2018-2020.

In *conclusion*, B.10 grown in NJ, NY and VA had the lowest incidence of Bitter Pit of the 14 and 15 rootstocks evaluated.

Dr. Sherif also commented that "B.10 stock is the most outstanding rootstock in VA. Particularly with regards to its ability to reduce bitter pit incidence at harvest and after three months in cold storage for five consecutive years (2017–2021). In addition, our nutrient analysis of Ca, K, and Mg in the skin and flesh of B.10, G.41 (moderately sensitive), and V.6 (very sensitive) revealed that B.10 had significantly higher levels of Ca and lower levels of K and Mg than the other two rootstocks. Furthermore, additional biochemical analyses of cell wall components from the three rootstocks demonstrated that fruits from B.10 contained more free Ca, which is a far more significant factor than bound Ca, but is often disregarded by researchers."

Recommendations for Honeycrisp Rootstocks

- B.9 – Excellent for Bitter pit, one of the smallest tree sizes, **preferred in Western New York** along Lake Ontario -Fireblight tolerant, **takes extensive high-quality management to grow and perform**
- **B.10- excellent for bitter pit, M.9 size, Fireblight tolerant, cold hardy, productive, tolerant to replant disease, moderate resistant to woolly apple aphid.**
- G.969- Excellent for Bitter pit, larger more vigorous than M.9, M.7 size- very resistant to fireblight, cold hardy, not susceptible to latent virus, tolerant of replant disease, tolerant of phytophthora, high resistance to Wooly apple aphid.
- G.214- Excellent for bitter pit, fireblight tolerant,

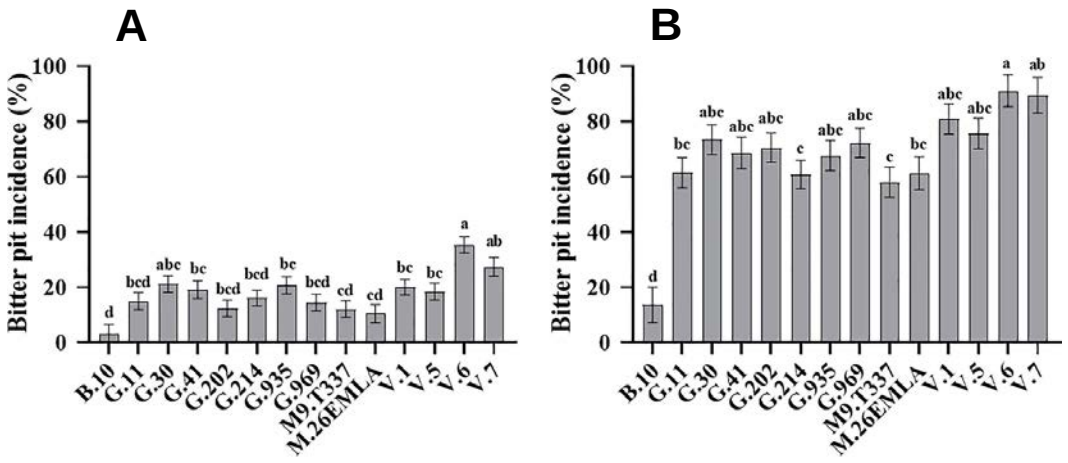
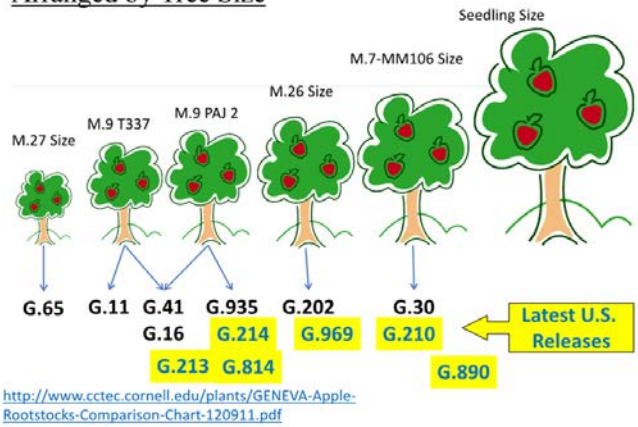


Figure 5. Rootstock effects on bitter pit (BP) incidence in 'Honeycrisp' apples. (A) Cumulative BP incidence at harvest (each bar represents the average of four growing seasons); (B) cumulative BP incidence after three months of cold storage (each bar represents the average of three growing seasons). Means not sharing any letter are significantly different at a = 0.05., according to Tukey's HSD test in JMP Pro16.

slightly larger than M.9- smaller than M.26, very resistant to fireblight, cold hardy, not susceptible to latent virus, tolerant of replant disease, tolerant of phytophthora, high resistance to woolly apple aphid, consider for use, harder to find.

- Do not use G.41- Extensive bitter pit, remains juvenile and thus delays productivity in years 2-5 (shy bearer).
- Do not use M.9 clones, fireblight issues.

Appendix



Geneva Apple Rootstock Chart.

References

- **Rootstock effects on bitter pit incidence in 'Honeycrisp' apples are associated with changes in fruit's cell wall chemical properties**
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- *https://bud10rootstock.com/*
- **Big Breakthrough When It Comes To Bitter Pit and 'Honeycrisp' Apples**
- *https://www.growingproduce.com/fruits/apples-pears/big-breakthrough-when-it-comes-to-bitter-pit-and-honeycrisp-apples/*
- **Geneva Apple Rootstock Comparison Chart** *https://ctl.cornell.edu/wp-content/uploads/plants/GENEVA-Apple-Rootstocks-Comparison-Chart.pdf*
- **Rootstock effects on bitter pit incidence in 'Honeycrisp' apples are associated with changes in fruit's cell wall chemical properties**
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Thank you to

- NC140 http://nc140.org
- Dr. Sherif- VPI
- Dr. Terence Robinson- Cornell
- New Jersey State Horticultural Society for Research Support of NC140 – nc140.org
- NJ Agricultural Experiment Station – Support of NC140
- Rutgers Snyder Research and Extension Farm