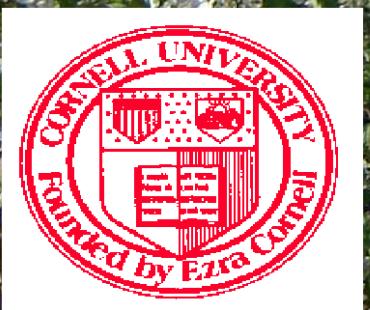


The Strengths and Weaknesses of Geneva Apple Rootstocks



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Leo Dominguez, Rafael Parra, Darius Kviklys, Brent Black, Richard
Adams, Stuart Adams, Tom Auvil, Ian Merwin

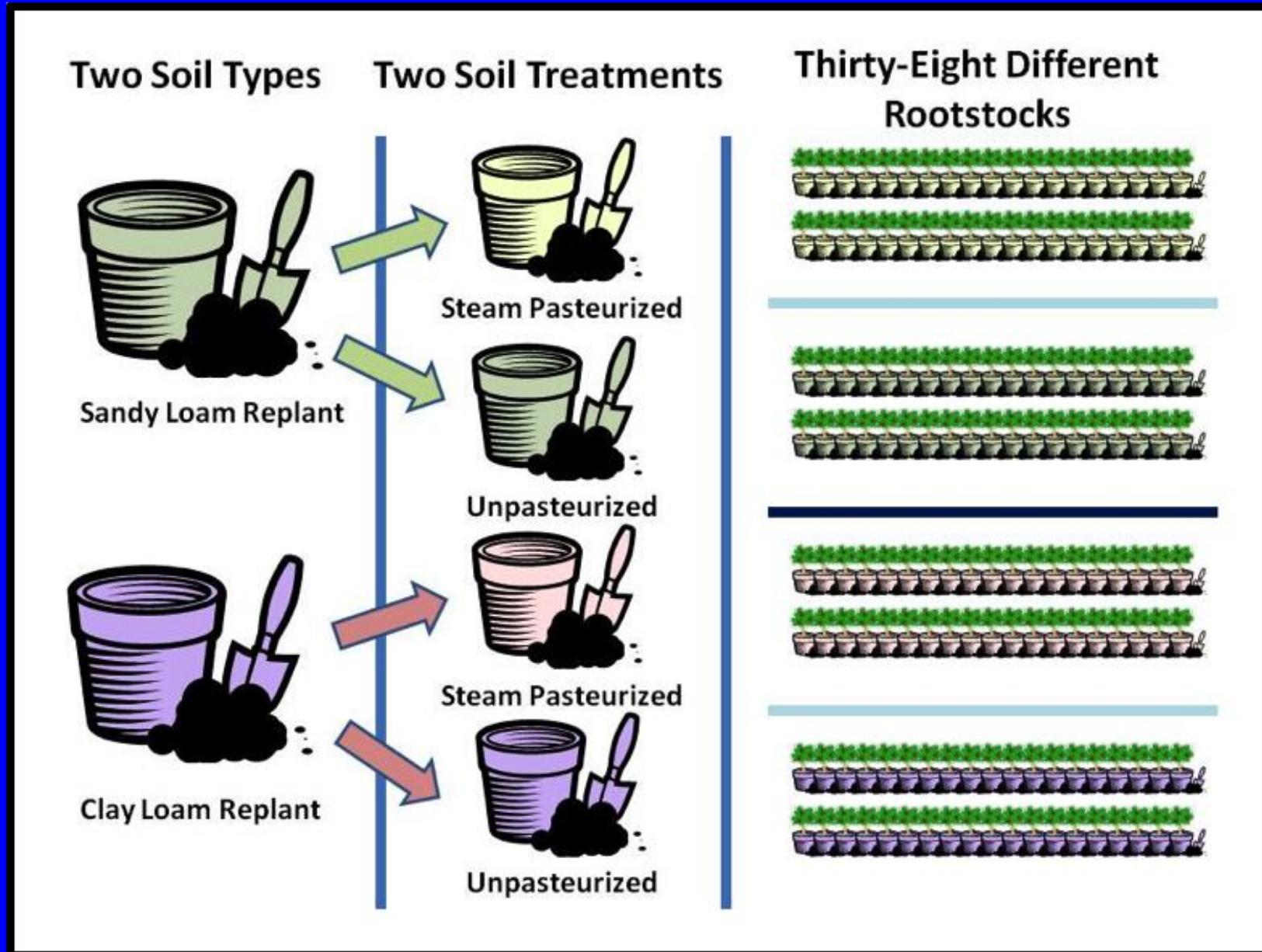
Strengths: 1) Apple Replant Disease Tolerance

Keys to Successful New Apple Orchards

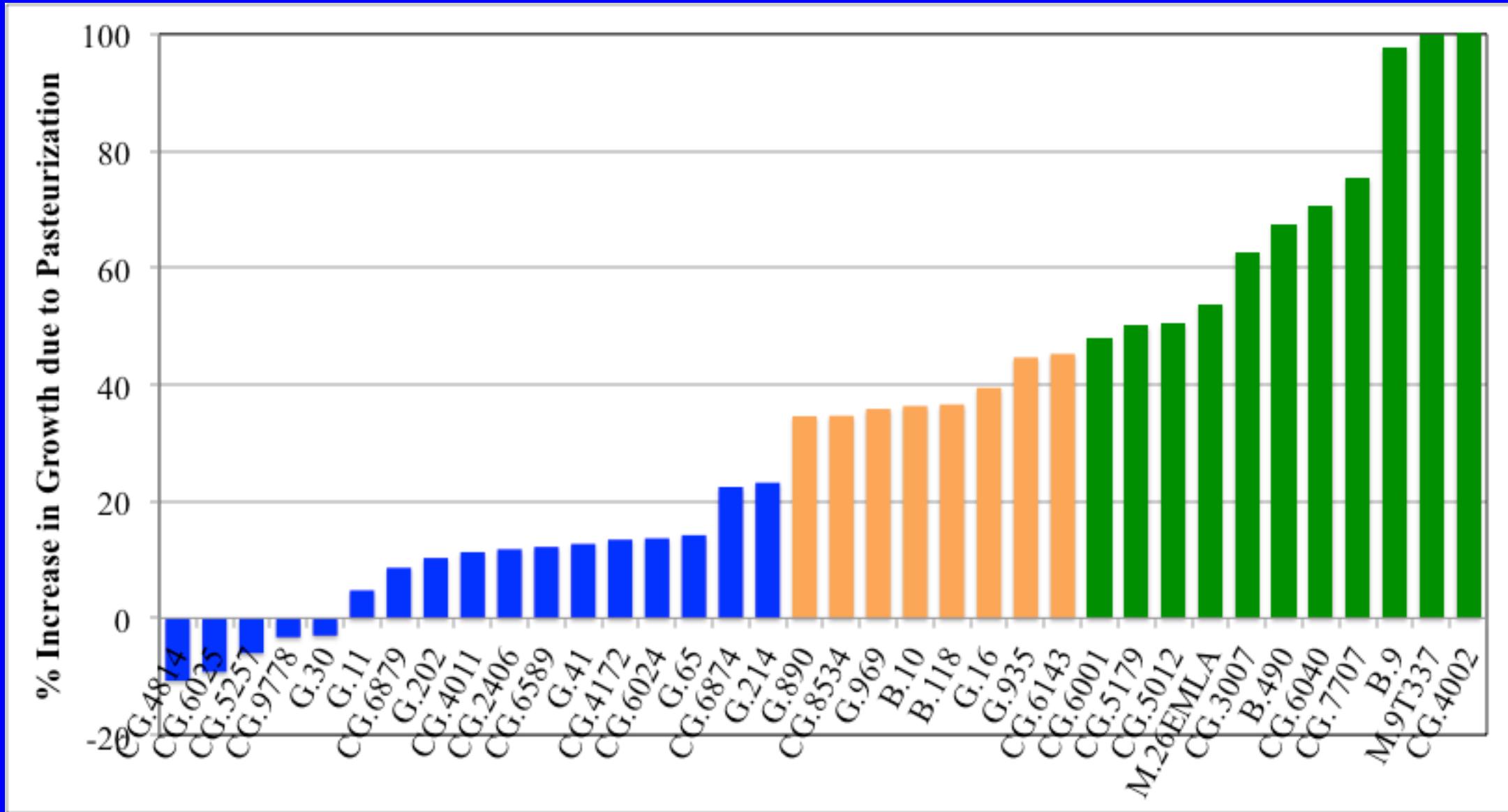
- Plant high-tree densities (optimum 1,000-1800 trees/acre).
- Produce high early yields (3,000 bu/acre over the first 5 years).
- Grow the trees rapidly to fill the allotted space in the first 3 years.
- Produce high mature yields (>1200 bu/acre) of high quality fruit.
- Poor tree growth due to replant disease in the first 3 years jeopardizes the economic success of the new orchard.



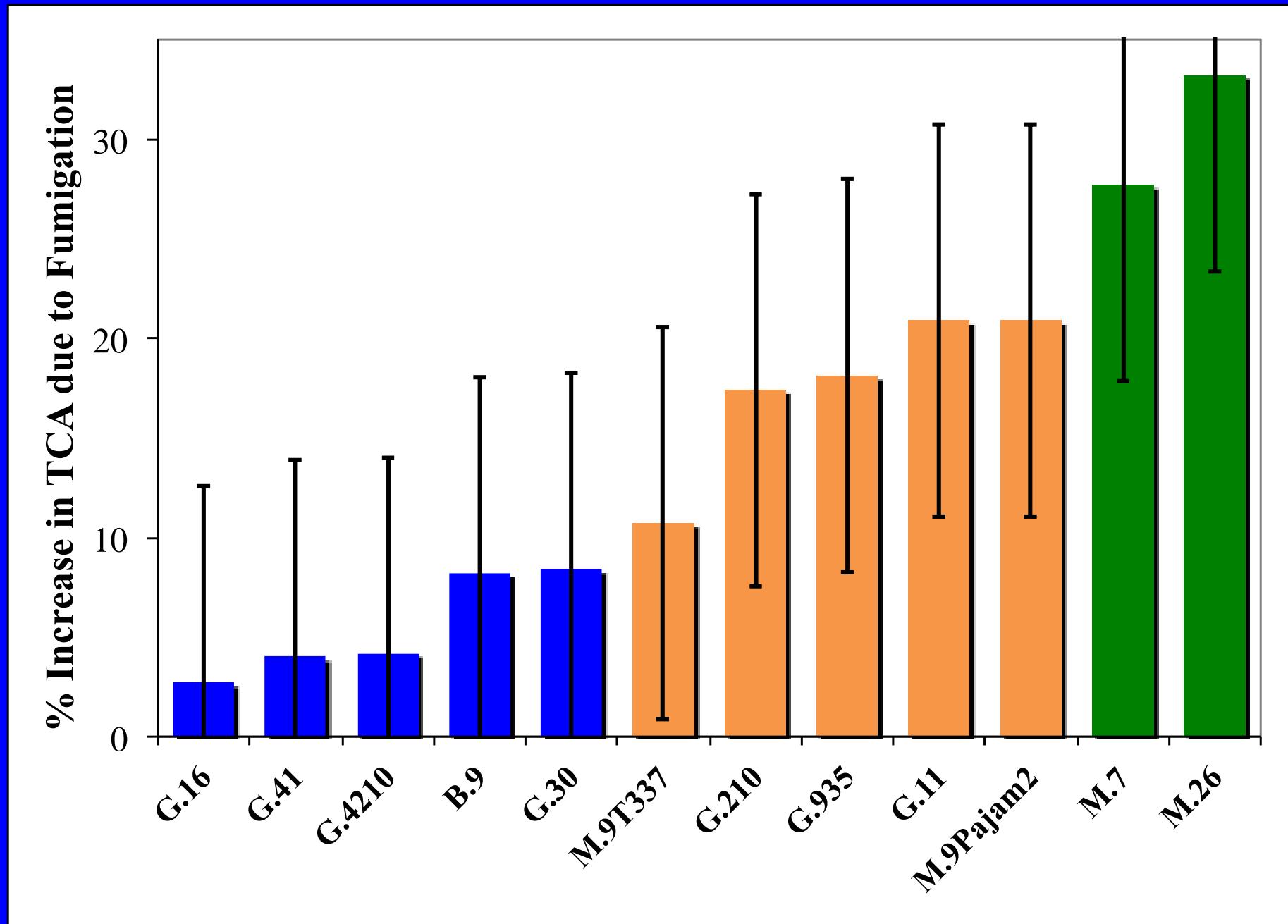
Geneva Replant Disease Evaluation of 38 Genotypes



Rootstock Tolerance to Replant Disease in Potted Trees

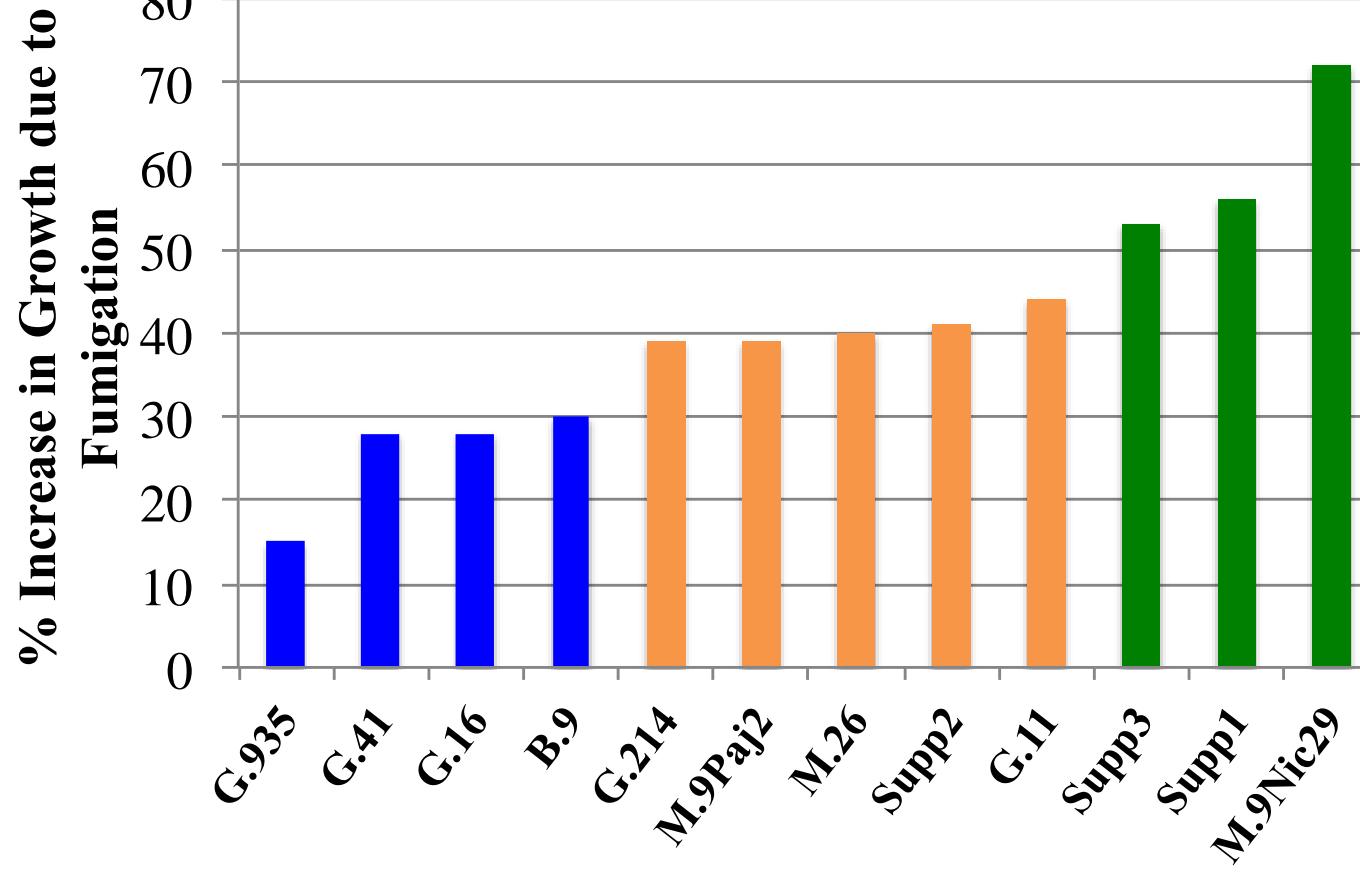


Field Tolerance to Replant Disease at 8 Locations in North America



Growth of Gala in a Replant Soil

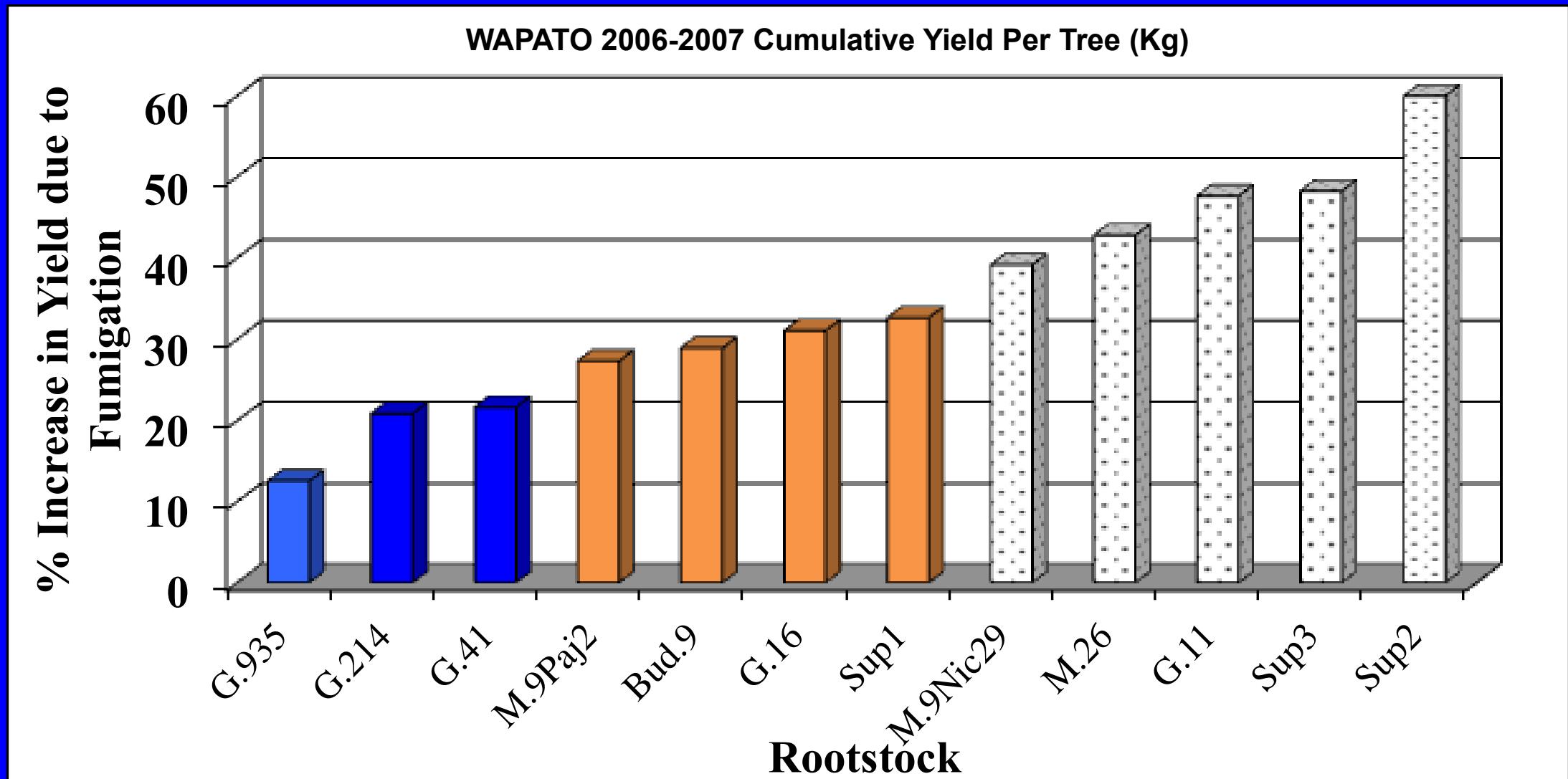
Washington State



Data from Auvil et al. 2010

Early Yield Improvement of Gala due to Fumigation in a Replant Soil

Washington State



Data from Fazio

Summary of Replant Resistance Studies

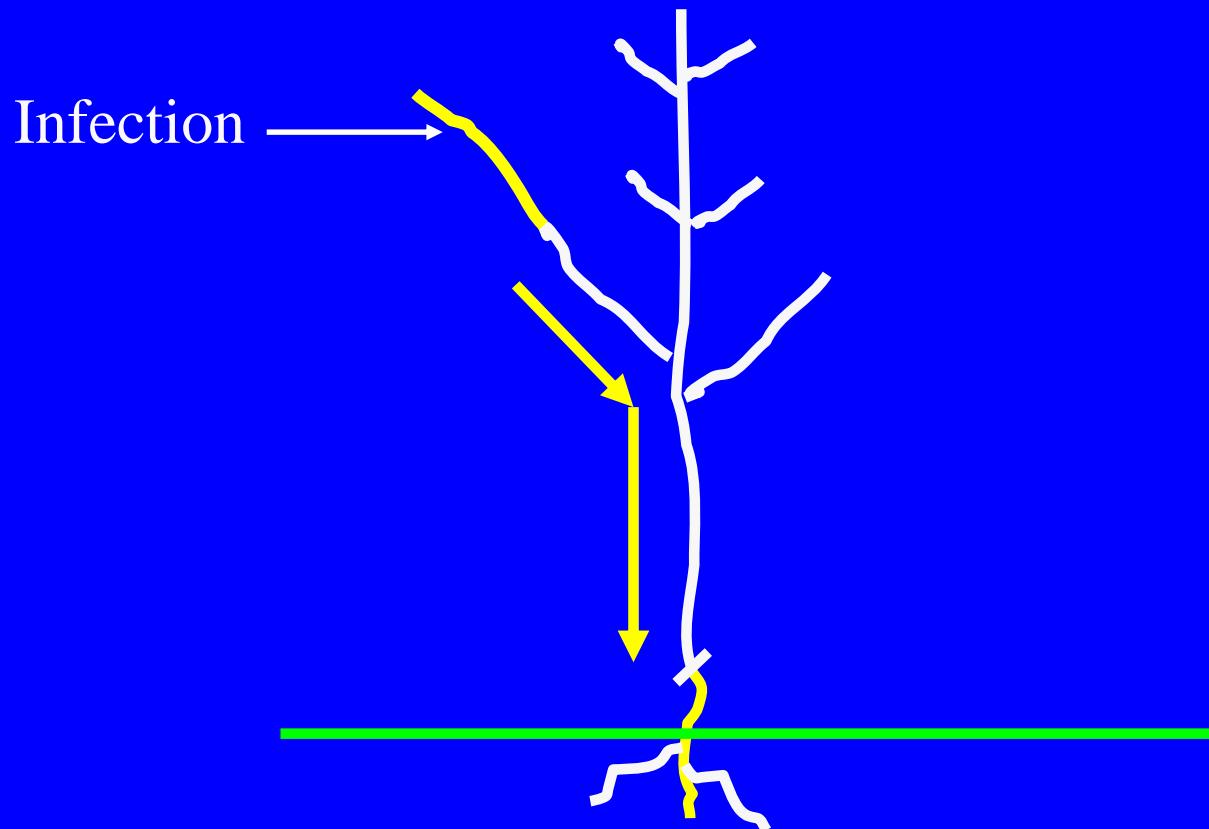
Study	G.11	G.41	G.214	G.935	G.210	G.30	M.9	M.26
Robinson 1991	--	T	--	T	R	R	S	S
Isutsas 2000	S	--	--	--	R	R	--	--
Laurent 2010	--	S	--	R	R	S	S	R
Kviklys 2012	R	R	R	T	--	R	S	S
White 2000	--	--	--	--	--	--	--	R
Robinson 2012	T	R	--	T	T	R	T	S
Auvil 2010(Wapato)	T	R	T	R	--	--	--	T
Auvil 2010(Chelan)	--	R	--	R	--	--	S	S
Average	T	R	R	R	R	R	S	S

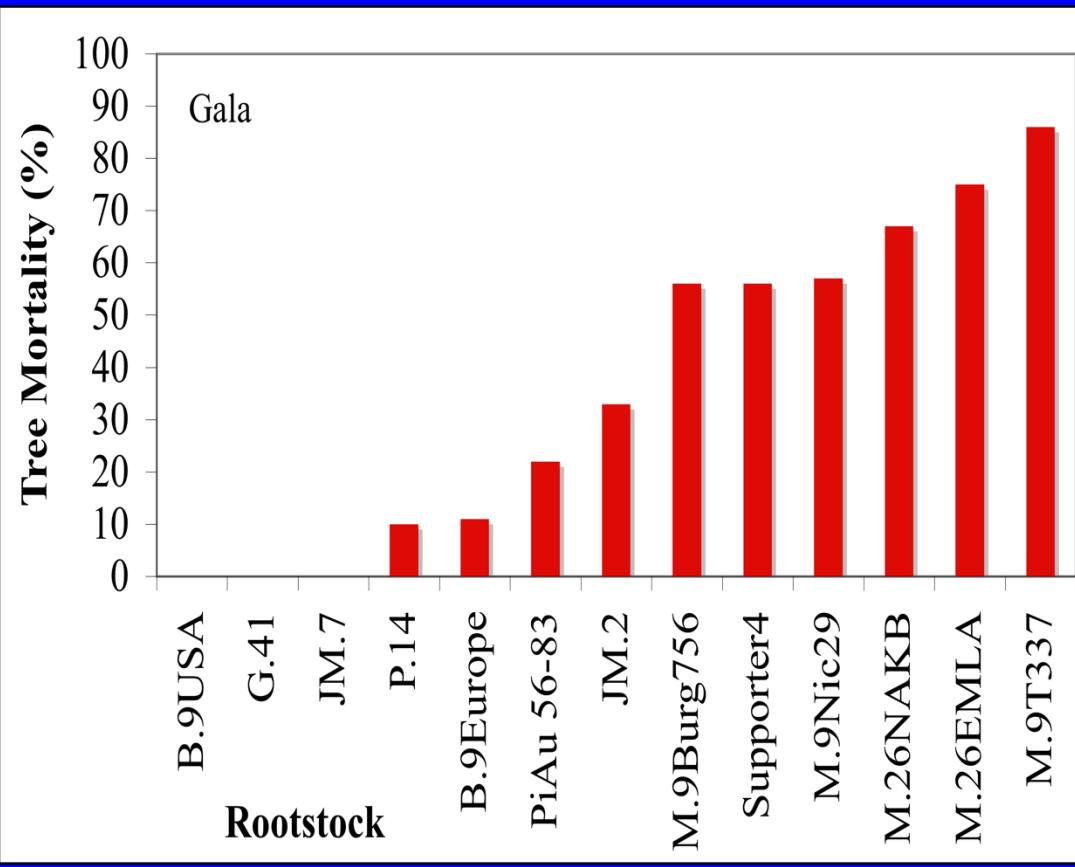
Summary

- Several Geneva® rootstocks appear to have tolerance/resistance to apple replant disease.
 - G.11
 - G.41
 - G.214
 - G.935
 - G.202
 - G.210
- The resistance may be due to the initial screening for Phytophthora disease which may also have selected for tolerance to other soil microorganisms.
- Resistant rootstocks show an improvement in yield due to fumigation.
- The variation around the world in soil organisms which cause apple replant disease may result in variable orchard results with the resistant rootstocks.

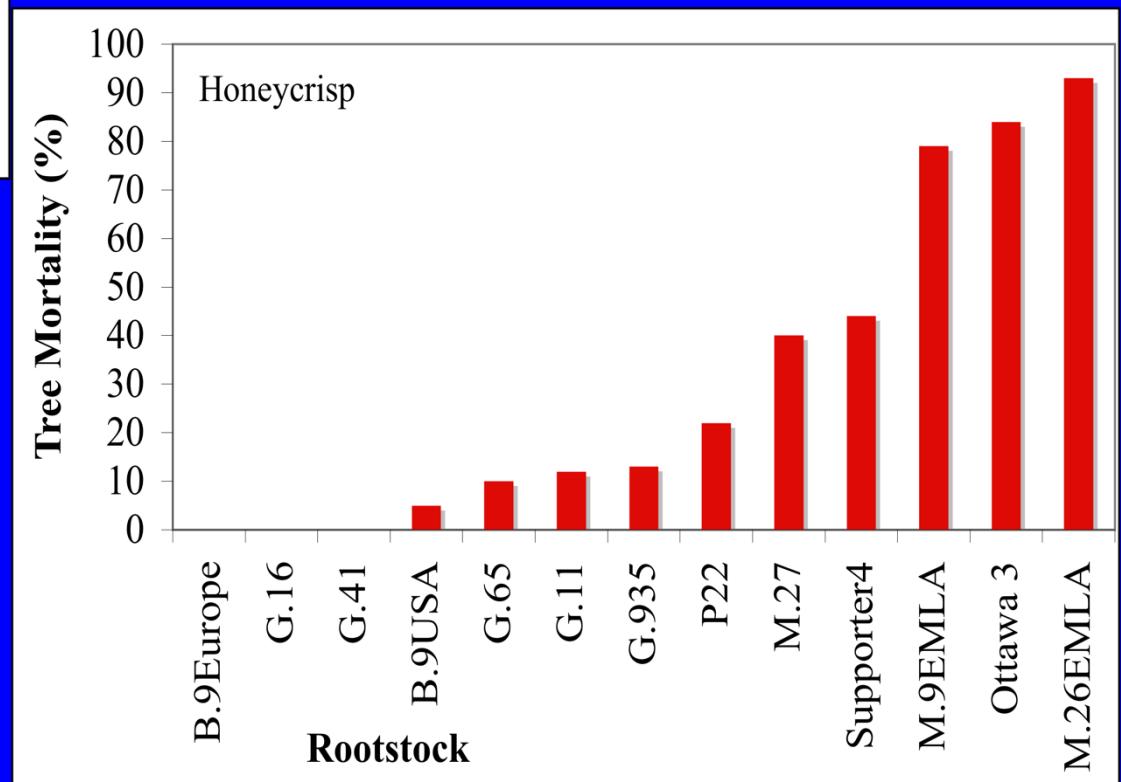
2. Fire Blight Resistance

- Infection of Rootstocks is a Major Problem in the USA
- Infection of susceptible rootstocks results in the death of the tree

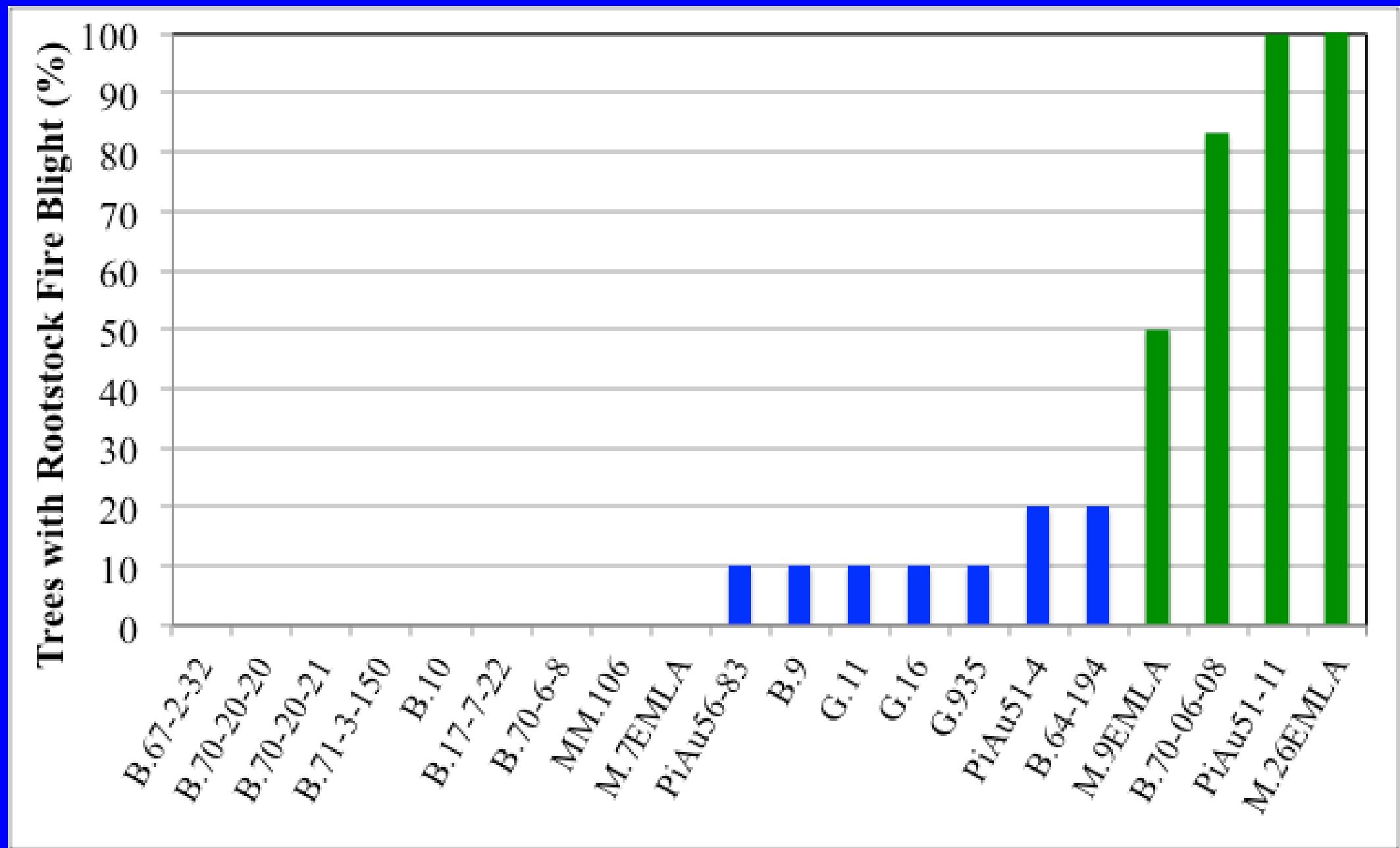




The Geneva® rootstocks
are much more resistant
to fire blight than most
other rootstocks.



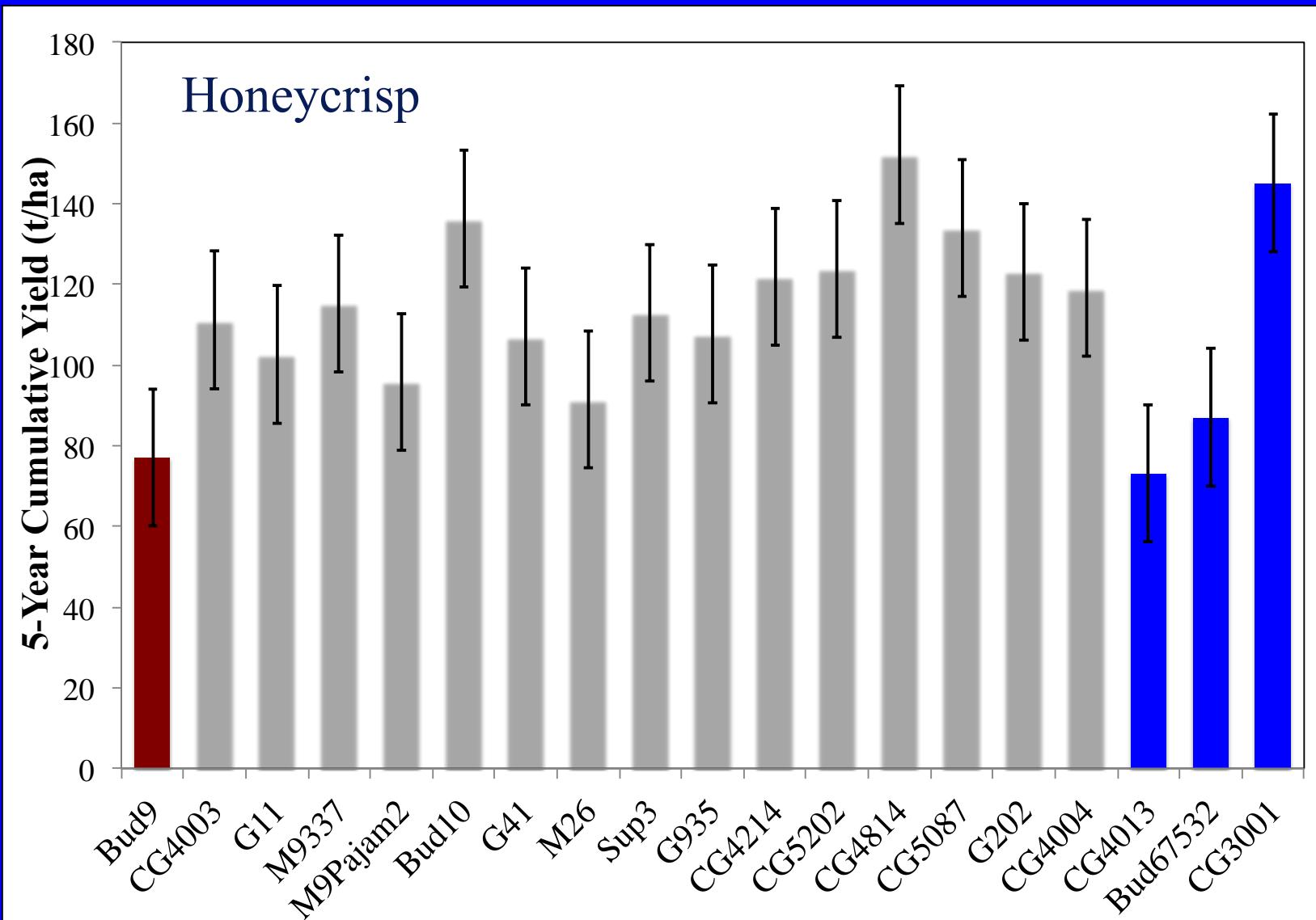
Rootstock Blight Development after Inoculation of Gala Trees on Various Rootstocks



Summary of Fire Blight Inoculation Trials

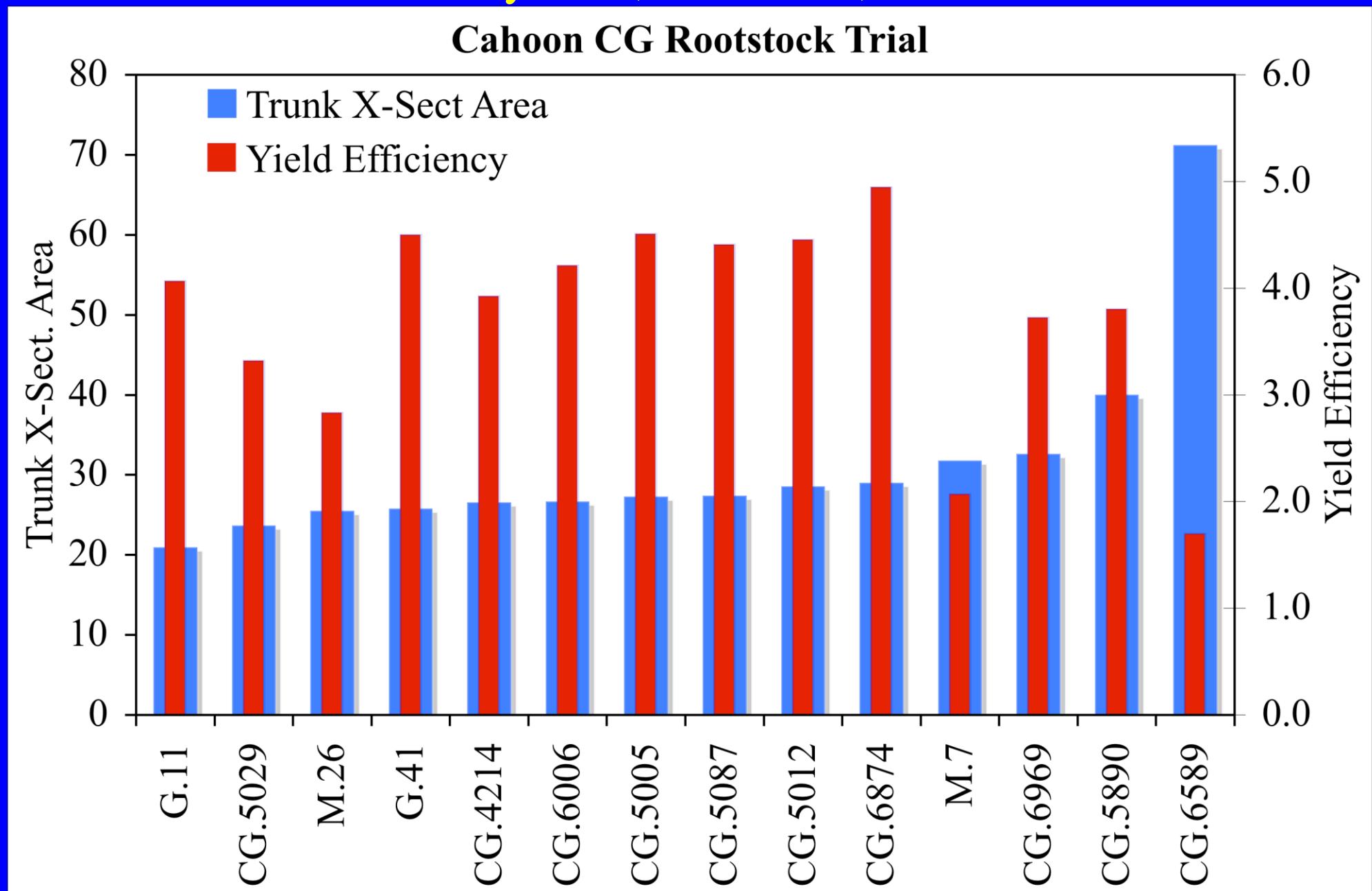
- G.16, G.41, G.214 and G.202 are highly resistant to fire blight but may not be resistant to all strains of fire blight.
- G.11, G.65 and G.935 are resistant to field inoculations of the scion with fire blight.

3. Yield potential of the Geneva Rootstocks

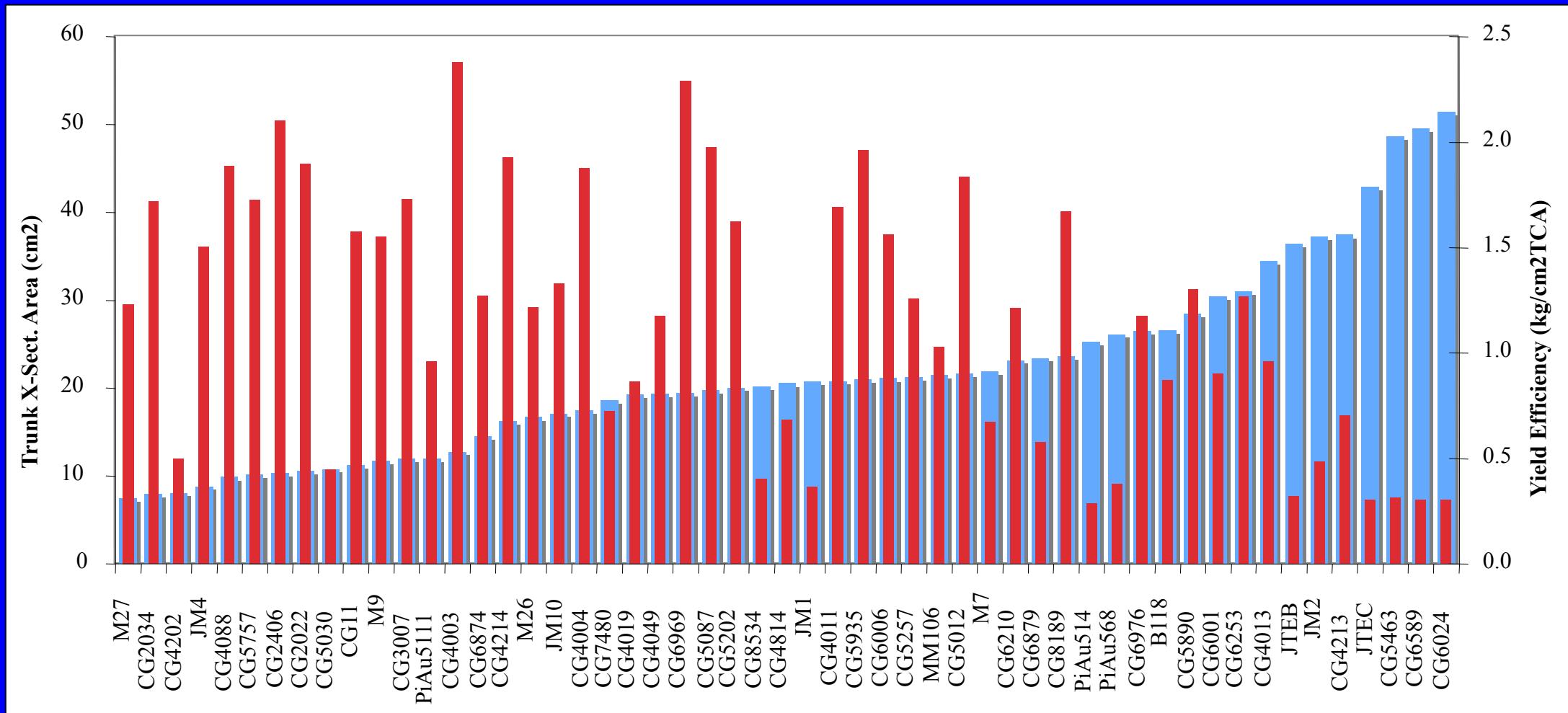


Example
G.814=152t/ha
B.9=77t/ha
Diff.=75t/ha
Value=\$56,850/ac

Performance of Golden Delicious with Geneva Rootstocks after 10 years (Cahoon Plot)



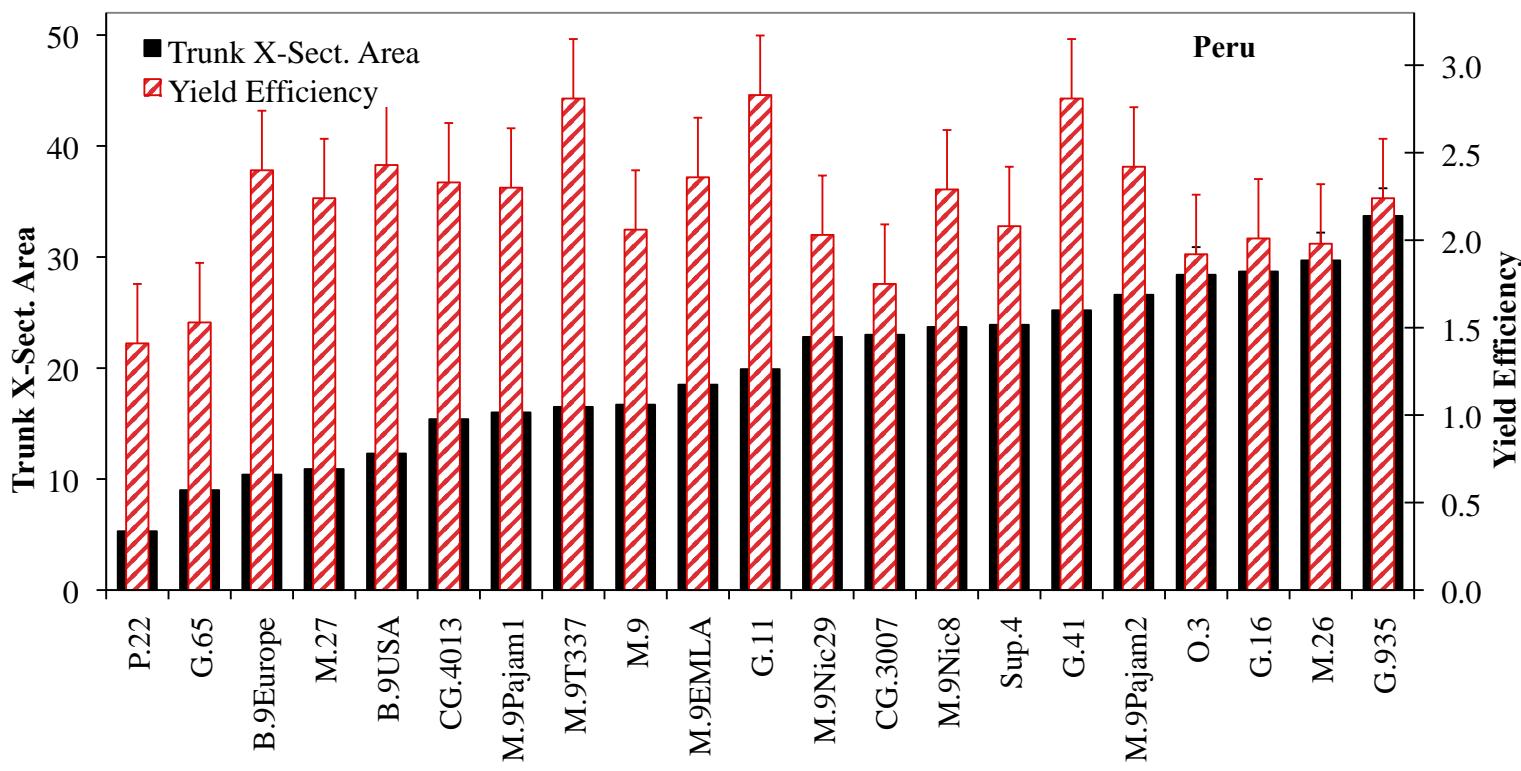
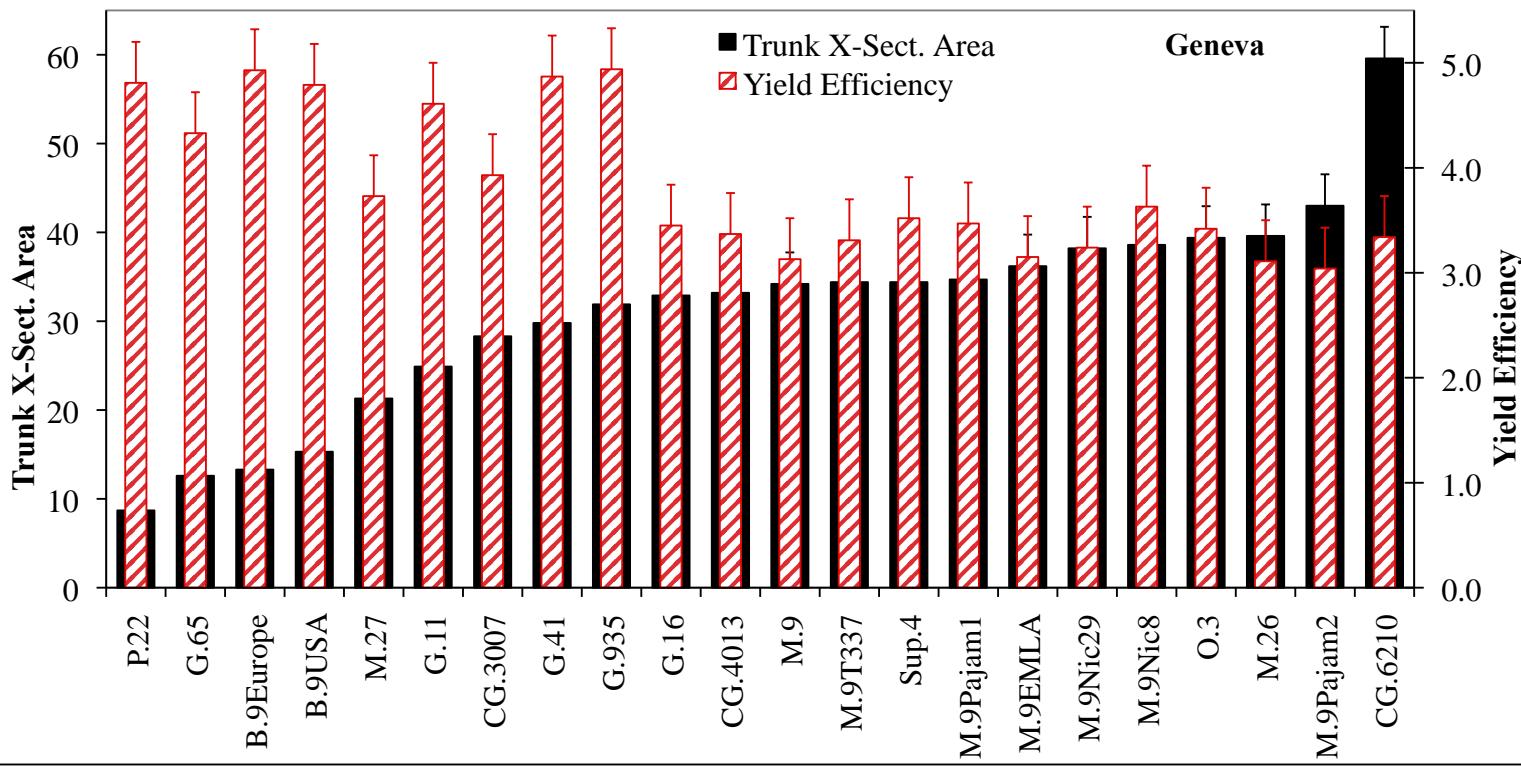
Performance of Fuji with 53 Rootstocks (Crist Bros. Plot)



4. Cold Hardiness

In the cold snap of 2004 and 2005, G.16, G.30, G.41 and G.935 had the best survival

G.41 and G.935 seem well adapted to the cool climate of the Champlain Valley



5. Woolly Aphid Resistance

Several Geneva stocks are resistant but some are not

G.41

Susceptible

G.11

G.214

G.935

G.202

G.210

G.969

G.222

G.890

Weaknesses: 1. Propagation of Geneva® Rootstocks

- Several Geneva Rootstocks root poorly in the stoolbed.
- We have conducted research to improve stoolbed performance
 - Regalis treatment of stoolbed
 - Tissue Culture to induce greater juvenility in stoolbed
 - Tissue Culture plants as rootstocks



Rooting of G.41 Apple Rootstock from tissue culture plants



Propagation by Cuttings is Expanding



Typical Rooting of G.41

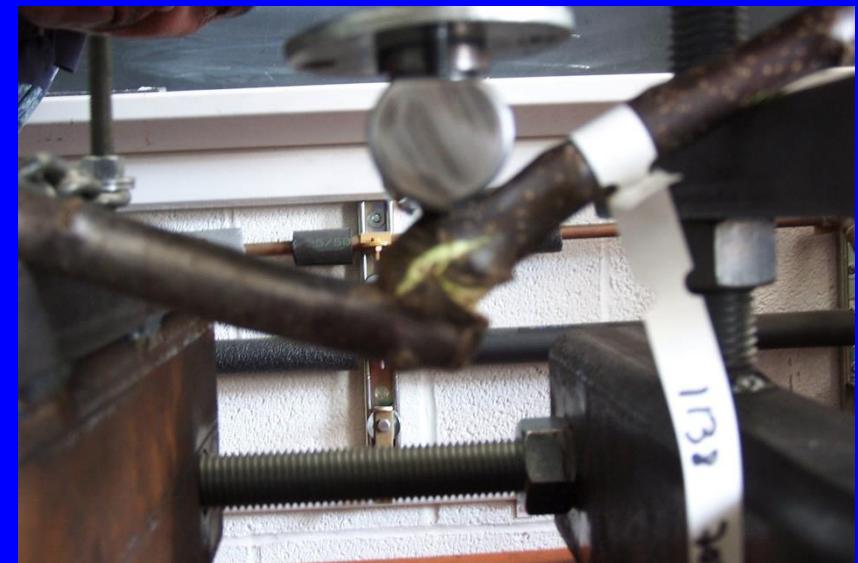
Weaknesses: 2) Graft Union Strength

- Some Geneva Rootstocks have a more brittle graft union with certain varieties.

Honeycrisp

Envy

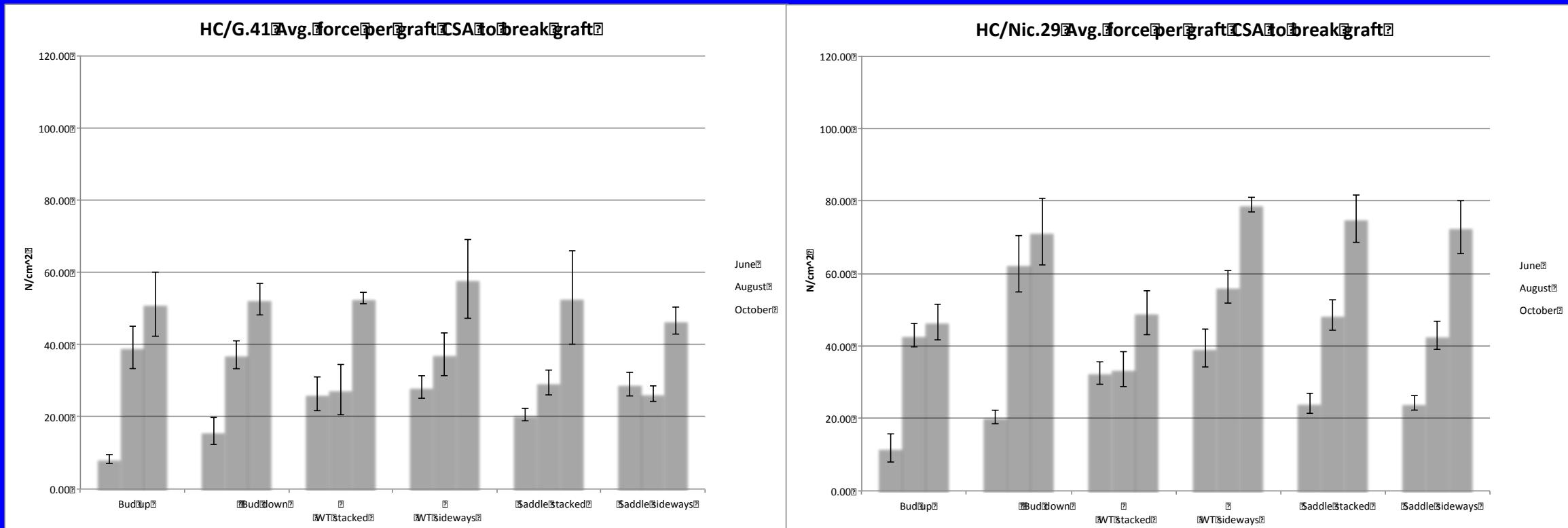
Crimson Crisp



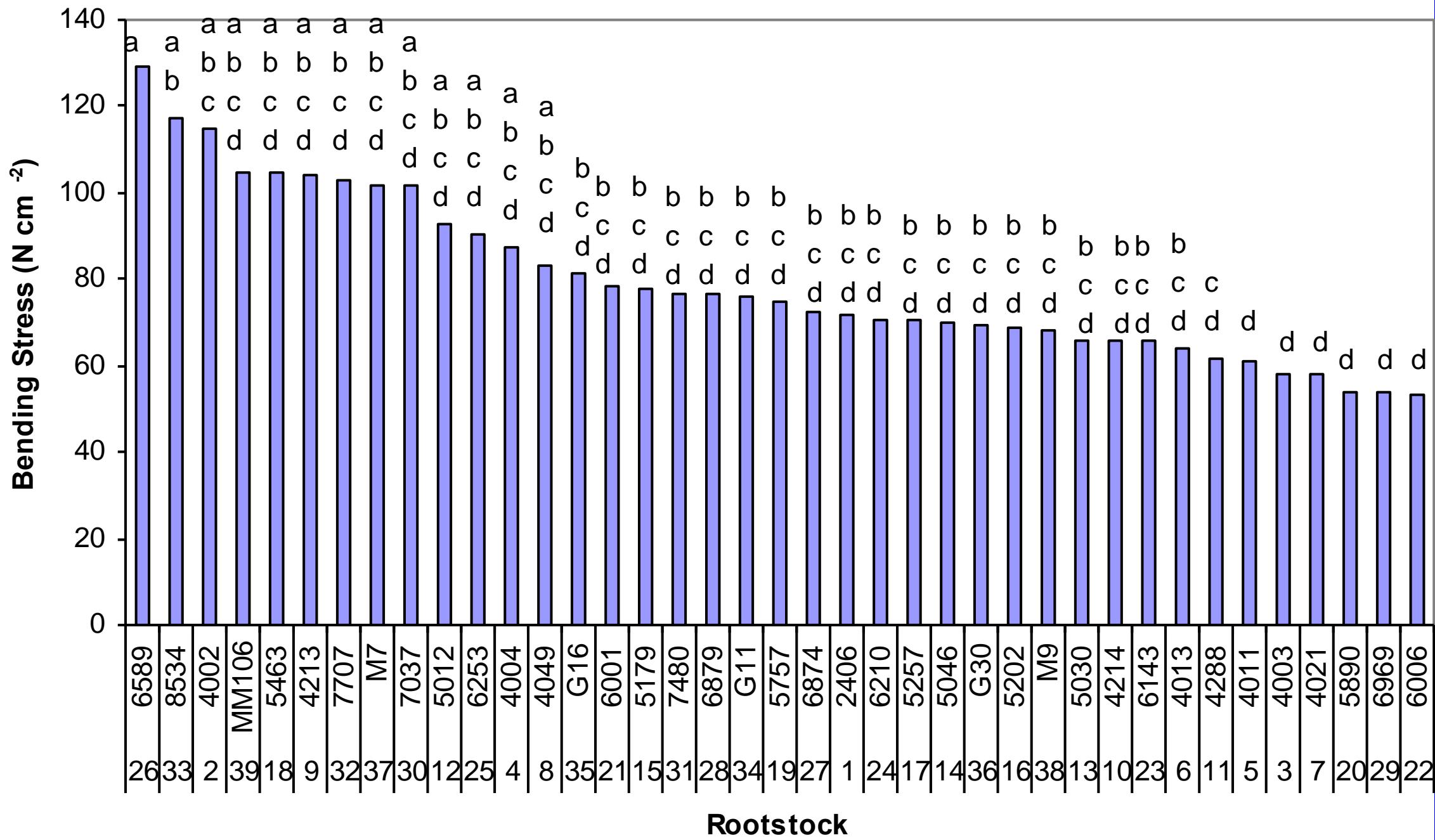
Graft union breaks of M.9Nic29 and G.41 with Scilate (Envy) as the scion variety



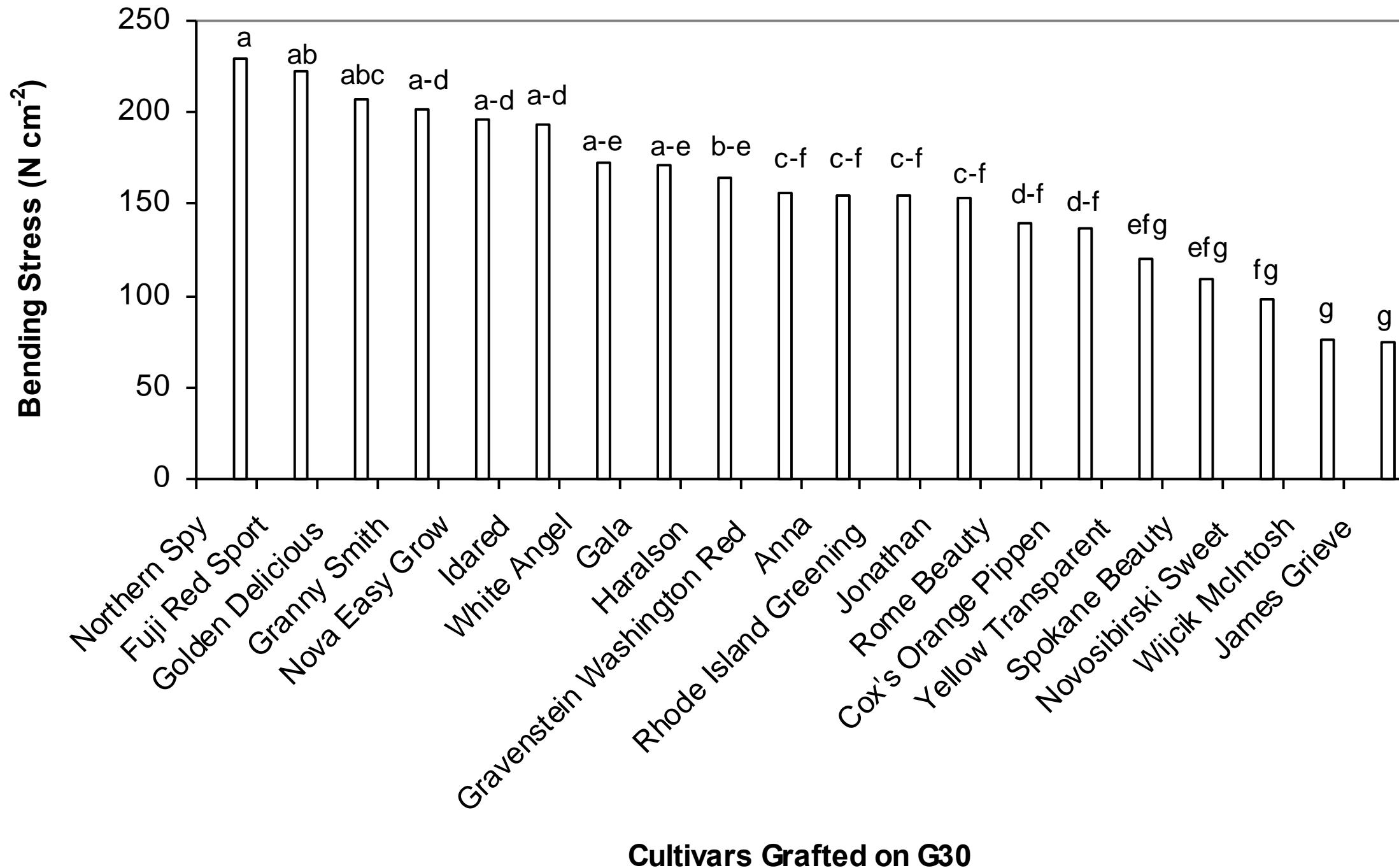
Graft Union strength of Honeycrisp on G.41 and M.9Nic29 in the Nursery



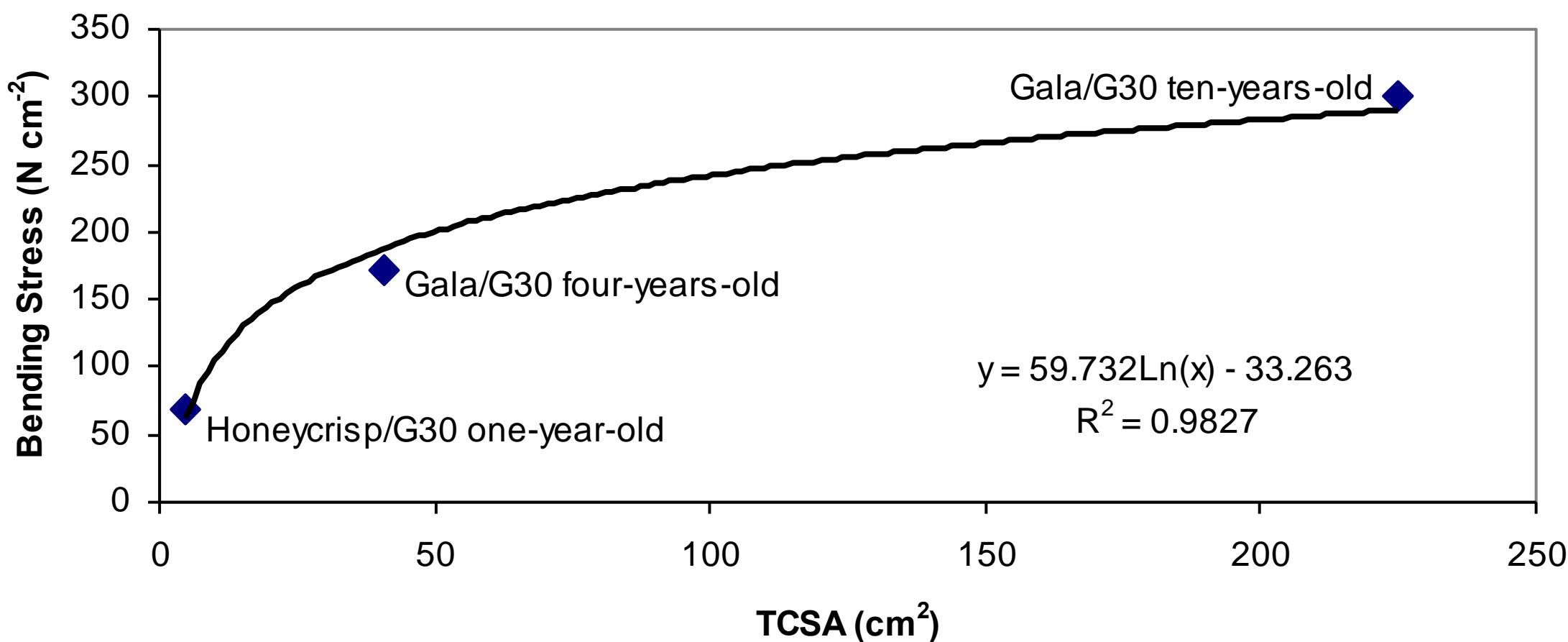
Graft Union strength of 39 rootstocks with Gala as the scion in the Nursery



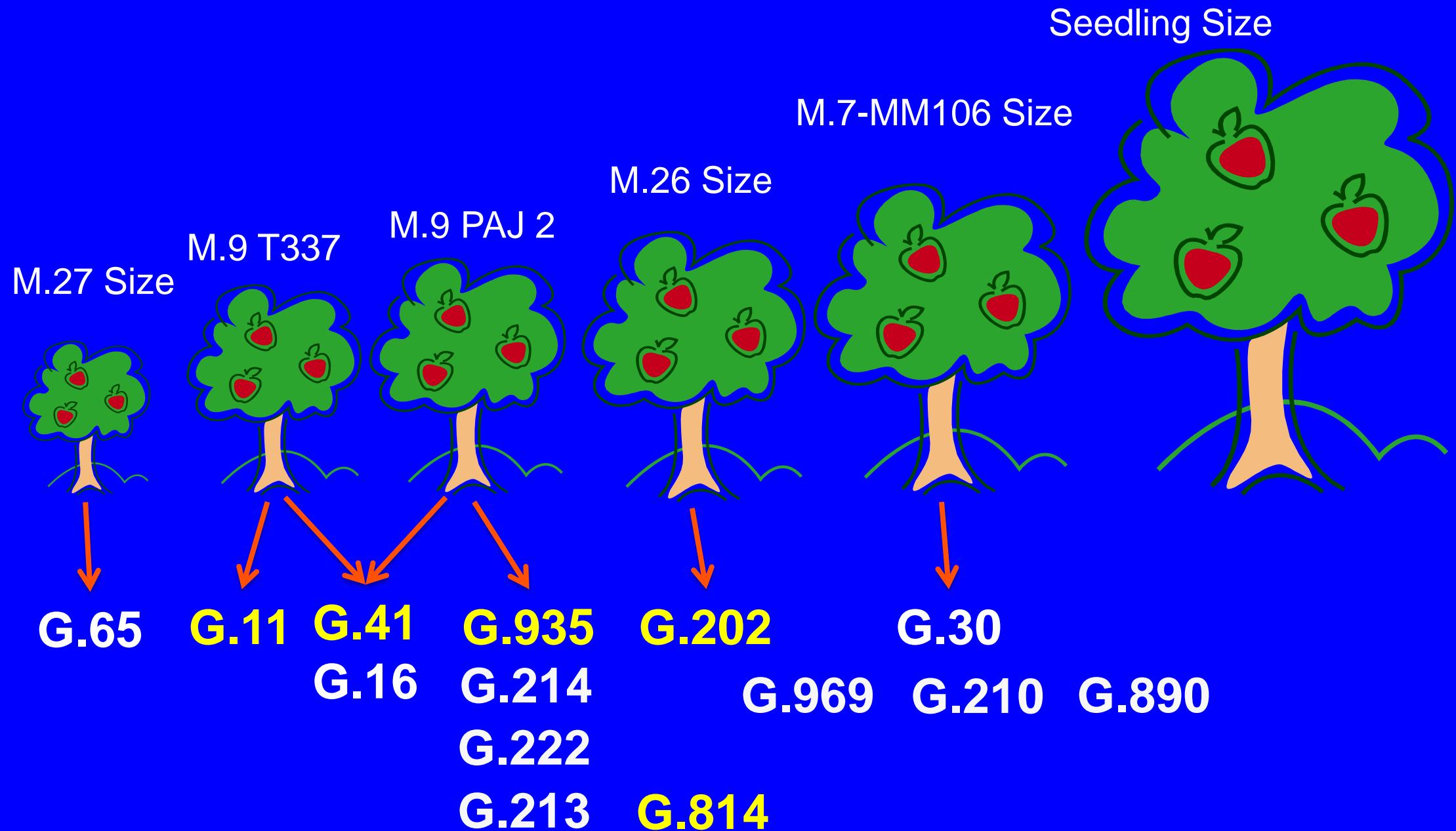
Graft Union strength of G.30 with 20 scion varieties in the Nursery



Graft Union strength of G.30 over 10 years



Released Geneva® Apple Rootstocks Arranged by Tree Size



Commercialization of Geneva® Rootstocks in North America

- Licensed Nurseries:

Willow Drive Nursery (Washington)

Willamette Nursery (Oregon)

North American Plants (Oregon)

Treco (Oregon)

Kit Johnston (Oregon)

Todd Cameron (Washington)

Copenhagen (Oregon)

Mori Nursery (Canada)

KCK Farms (Oregon)

Van Well Nursery (Oregon)

Helios Nursery (Washington)

Pyteligence (Washington)

ProTree (California)

Crown Nursery (Washington)

Consortio Sacramento (Mexico)

- Rootstocks

G.11 G.41

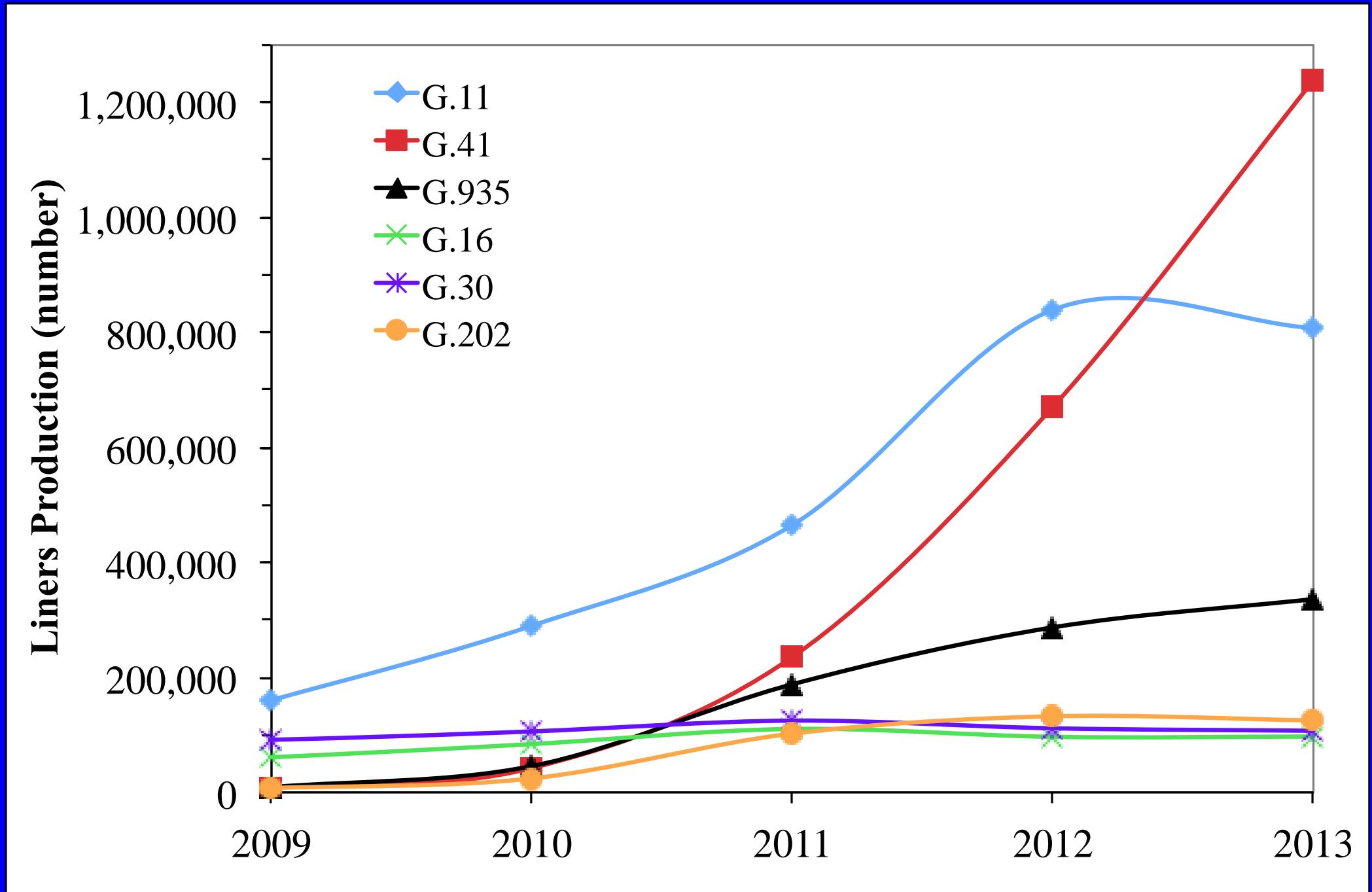
G.214 G.935 G.222

G.202 G.969

G.30 G.210 G.890



Geneva Rootstock Liner Production in the USA



G.11

- Tree size similar to M.9 T337.
- Very high yield efficiency
- Large fruit size
- Tolerant to Replant Disease
- Resistant to Fire Blight but not immune.
- Resistant to Crown Rot
- Susceptible to Wooly Apple Aphid
- Good rooting in stoolbed



G.41

- M.9 vigor
- Very high yield efficient
- Highly productive
- Very precocious
- Resistant to replant disease
- Very cold hardy
- Does well in warmer climates (Mexico)
- Highly Resistant to Fire Blight and Crown Rot and Wooly Apple Aphid
- Requires tissue culture mother plants for stoolbed



G.935

- Vigor intermediate between M.9 Pajam 2 and M.26
- Very high yield efficiency
- Very cold hardy
- Resistant to Replant Disease
- Resistant to Fire Blight and Crown Rot
- Susceptible to Wooly Apple Aphid



G.202

- Size similar to M.26
- Precocious, productive
- Resistant to woolly apple aphid, fire blight, and crown rot
- Tolerant to apple replant disease
- Good choice for weak growing cultivars like Honeycrisp
- Moderate rooting in stoolbed



G.202 New Zealand

G.214

- Vigor similar to M.9 Pajam2
- Highly yield efficient
- Highly productive
- Good precocity
- Tolerant to replant disease
- Resistant to Fire Blight, Crown Rot and Wooly Apple Aphid
- Very good stool bed propagation
- No commercial production of liners.



G.214 Washington

G.969

- Vigor between M.26 y M.7
- Very efficient and productive
- Very cold tolerant
- Resistant to fire blight
- Resistant to Phytopthora
- Resistant to Woolly Apple Aphid
- Good Anchorage
- Excellent rootstock for weak scions like Honeycrisp



G.210

- Vigor between M.7 and MM.106
- Precocious, productive
- Yield efficiency similar or better than M.9
- Resistant to apple replant disease.
- Resistance to woolly apple aphid, fire blight, and crown rot.
- Good rooting in stoolbed few spines.
- Mostly for Organic Production

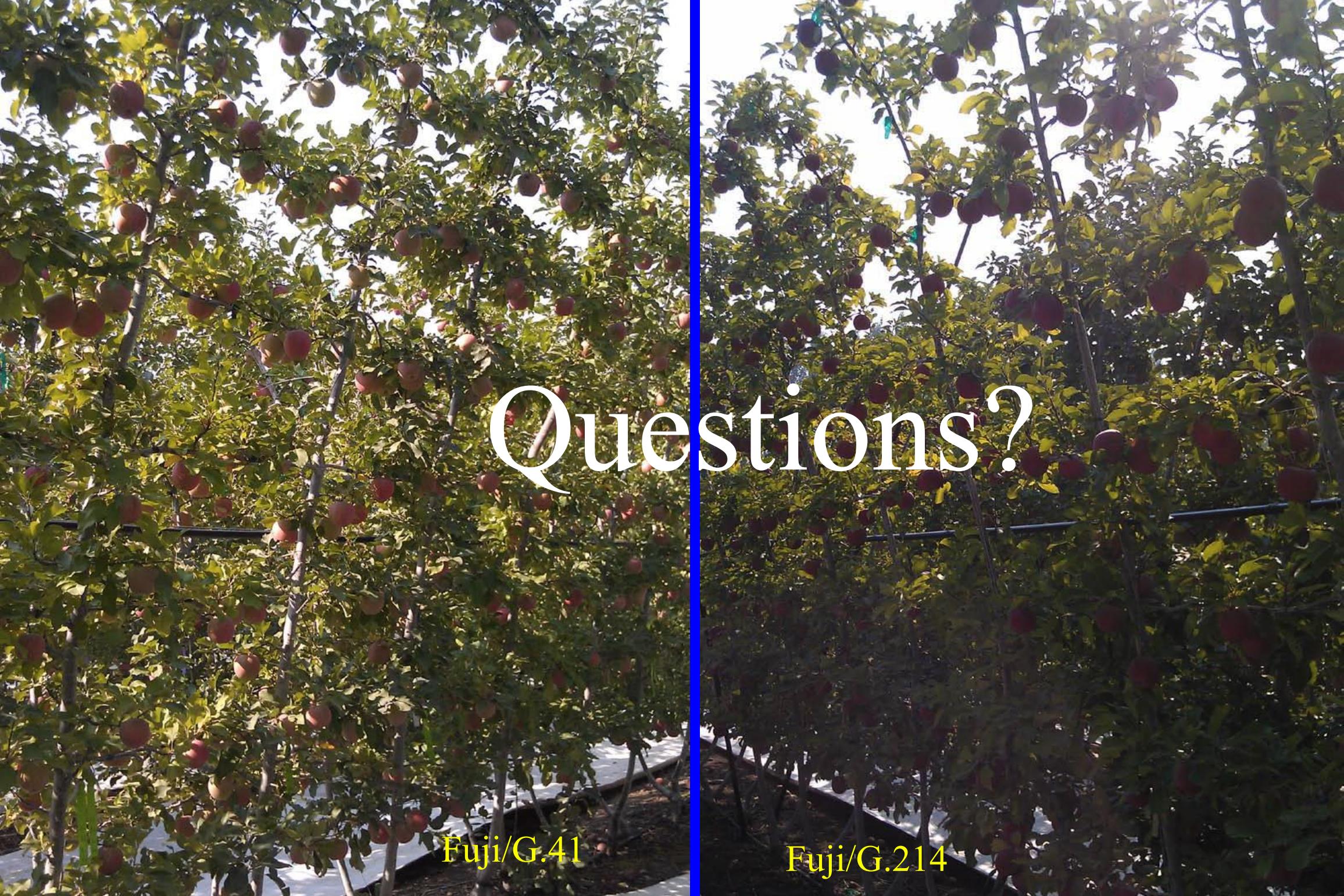


G.210

With Several New Rootstock Options of Varying Vigor Levels the Challenge Becomes Selecting the Rootstock that Gives the Best Combination of Growth and Yield for the Variety We are Planting



G.11 for strong varieties
G.41 for weak varieties or replant
G.935 or G.202 for very weak varieties



Questions?

Fuji/G.41

Fuji/G.214