Apple Varieties and Rootstocks and Training Systems

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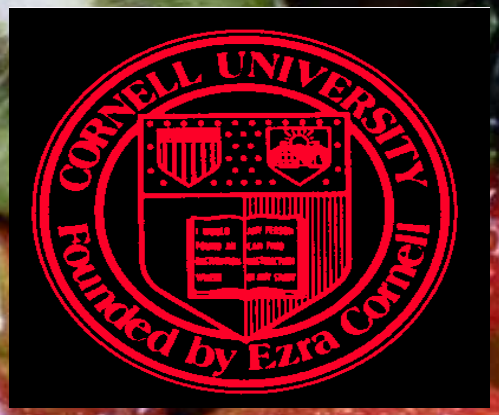


What is the Future of the Apple Industry? Should We Replant and Continue to be a Player, or become a Former Player?

The Opportunity:

- **Well managed new planting systems mean early production and high mature yields.**
- **Exciting new varieties on the horizon from breeding programs.**
- **New technologies will improve fruit quality.**
- **Low interest rates.**

Successful Apple Businesses

- Have products (varieties) that people want.
- Develop new markets for their products.
- Efficient producers.
- Develop new products (varieties) that are in greater demand while eliminating products (varieties) that have poor demand.
- Eliminate poor performing blocks.
- Willingness to change as markets change.

Cornell Recommendations

- Each fruit farm needs to be on a continual replanting program to remain competitive over the long term.
- Replanting allows farms to eliminate poor performing blocks and develop new higher yielding blocks.
- Replanting allows farms to develop new products (varieties) that are in greater demand while eliminating products (varieties) that have poor demand.
- We recommend that 4-5% of the farm be replanted annually.

The Problem: What to Plant?

- The marketers want the traditional varieties (McIntosh, Empire, Delicious) that they can sell. However, these often are sold for $4-6 per carton.
- Newer varieties often generate higher fruit prices for the first few years but they are more difficult to market. Thus they are riskier.
- Occasionally a new variety generates very high fruit prices. e.g. Honeycrisp.

What to Plant?

- To minimize risk, plant the best of the wholesale varieties on 50% of new orchards.
  - McIntosh -
  - Empire - Royal (with MCP)
  - Gala -
  - Cortland (with MCP)
- To generate high returns, plant niche varieties that have high fruit prices on 40% of new orchards.
  - Honeycrisp
  - Jonagold -(with MCP)
  - Macoun
  - Fuji - early strains
  - Gingergold (with MCP)
- Gamble for very high returns on a small acreage (10%)
  - Ambrosia, Cameo, Pacific Rose, Pinata, Topaz etc.

Some Suggestions: Direct Marketing

Pristine
Ginger Gold
Golden Supreme
Honeycrisp
McIntosh: strains to spread out maturity
Cortland- Royal Court
Empire
Sonata
BCVariety: 8S-27-43
Fuji: Auvil Early,Sept. Wonder
Braeburn: earlier strains
Goldrush
Hampshire
Zestar!
Sansa
Gala strains to spread maturity
NY674
Macoun
Jonagold-Rubinstar, Decoster
Ambrosia
Cameo
Fortune
Granny Smith
Topaz
Pinova (Pinata)

Suggestions: Wholesale Market:

- Zestar! (to replace Paula Red)
- Gala striped strains to spread maturity
- NY 674
- Honeycrisp
- McIntosh – Linda Mac / Acey Mac
- Cortland -Royal Court. Redcort
- Sonata
- Jonagold Rubinstar Decoster
- Royal Empire
- Ambrosia
- Cameo
- Braeburn –earlier strain
- Fuji – earlier strain

Another Problem: What Rootstock to Plant?

- Rootstock performance varies around the country.
- There is great disparity of opinion on the optimum planting density.

- **Dwarfing Rootstocks are the Basis of Modern Apple Orchards**
- **They affects the earliness of cropping (precocity)**
  - **Time to payback initial investment**
- **They affect the amount of yield/tree (productivity)**
  - **Annual profitability**
- **They affect the size of the tree (dwarfing level)**
  - **Ease and cost of spraying**
  - **Ease and cost of picking**
  - **Ease and cost of pruning**

Current Apple Rootstocks:

- **Currently in the United States the most common apple rootstocks are M.9, M.26, B.9, M.7, MM.106, MM.111.**
  - **30% of the rootstocks are M.9,**
  - **20% are B.9,**
  - **20% are M.26,**
  - **10% are M.7,**
  - **9% are MM.106**
  - **5% are MM.111**
  - **2% are G.16**
  - **1% are G.30**

Clones of M.9

Rootstock	TCA (cm^2)	Yield Eff. (kg/cm^2)	Suckers
B.9	56.5 d	5.4 a	6.4 a
M.9Flueren56	58.1 d	5.2 ab	6.7 a
M.9T337	61.9 d	5.2 ab	7.4 a
O.3	66.5 b	5.0 a	5.0 a
M.9EMLA	72.4 c	5.1 ab	7.6 a
M.9Pajam1	78.0 bc	4.8 abc	8.1 a
M.9Nic29	80.9 abc	4.9 ab	8.5 a
M.9Pajam2	84.3 ab	4.6 bc	8.5 a
M.26	89.6 a	4.0 c	7.1 a

Uses of Clones of M.9

- **Use weaker clones of M.9 (Flueren 56 and T337) or B.9 with vigorous scion varieties such as McIntosh, Mutsu, Jonagold, and Fuji or with vigorous or virgin soil**
- **Use the vigorous clones (Nic29, Pajam2) or O.3 with weak varieties such as Delicious, Jonamac, Empire, Idared and Honeycrisp or with weak soils or on replant soils**

B.9

- Is a highly productive dwarfing stock that is similar in size to weak clones of M.9. (20-30% the size of seedling)
- It is more winter hardy than M.9. (not in 2004)
- It appears to have field resistance to fire blight.
- It is very susceptible to apple replant disease.
- Cautions: B.9 must be spaced very close to achieve high yields per acre. It may be too weak with weak scions.

M.26

- A highly productive dwarfing stock that produces a tree about 40% the size of seedling.
- It is very winter hardy (except in 2004)
- It performs well on good soils but will not tolerate wet soils or droughty soils.
- It is extremely fire blight susceptible.
- It is very susceptible to apple replant disease.
- M.26 remains very popular since in does well at intermediate densities.

M.7

- It was extensively planted in the 1970's and 1980's.
- It produces trees about 60% the size of seedling.
- It has wide soil adaptability and is quite tolerant of fire blight and apple replant disease.
- However, it is not cold hardy and it is not precocious.
- M.7 is not compatible with modern high density systems.

MM.111

- Is a semi-vigorous stock that produces trees 70-80% the size of seedling.
- It has wide soil adaptability and is quite drought tolerant.
- It was widely planted in the 1960's-1980's
- MM.111 has excessive vigor and has no place in high density orchards.

Apple Rootstock Improvement:

- Efforts to develop improved apple rootstocks have led to rootstock breeding programs in:
  - United States (CG, MAC, OAR, Ark and MN series)
  - Canada (KSC, Ottawa, Vineland series)
  - the United Kingdom (M, MI, MM, and AR series),
  - Germany (J9 and Pillnitzer-Supporter series),
  - Sweeden (Alnarp, BM series and Bemali),
  - Russia (Budagovskij series),
  - Poland (P series),
  - the Czech Republic (JT-E series,
  - Israel (MH series),
  - Romania (Voinesti series)
  - Japan (JM series).

Geneva Apple Rootstocks:

- **Initiated by Jim Cummins and Herb Aldwinckle in 1970.**
- **Converted to a national program with the USDA and Cornell University in 1998 and currently led by Gennaro Fazio of the USDA with several Cornell cooperators.**
- **Primary goals have been to develop fire blight and *Phytophthora* resistant rootstocks.**
- **Goals have now broadened to include tolerance to apple replant disease resistance and increased cold hardiness.**
- **7 Rootstocks have been released to date.**

Geneva® Rootstocks

M.27 Size	M.9 Size	M.26 Size	M.7 Size
G.65	G.11	G.935	G.30
	G.41	G.202	
	G.16		

G.11

- Tree size is between M.9 and M.26.
- Productivity is similar to M.9.
- Large fruit size.
- It is fire blight resistant but is not immune.
- Commercial sales in the US are just beginning.
- In European CG trial it has looked the best.
- Good rooting in stoolbed (close to M.9)

Performance of G.11

Trial	Rootstock	TCA (% of M.9)	Yield Eff. (% of M.9)	Fruit Size (% of M.9)
1992 Liberty	G.11	84 NS	114 NS	103 NS
1993 Liberty	G.11	140 *	95 NS	---

Performance of G.11 in France

(Masseron and Simard, 2001)

- Tree size was 15% smaller than M.9Pajam2 at 2 sites.
- Productivity was 14% greater than M.9Pajam.
- Fruit size was similar or better than M.9Pajam2.

G.41

- G.41 is similar in size to M.9.
- Its productivity is similar or better than M.9. In NY it has been the best rootstock in every trial.
- It is resistant to fire blight and crown rot.
- It is very winter hardy.
- It has moderate to poor propagation characteristics in the stoolbed.
- It appears to have graft union strength similar to M.9.
- It was released in the US in Feb. 2005

Performance of G.41

Trial	Rootstock	TCA (% of M.9)	Yield Eff. (% of M.9)	Fruit Size (% of M.9)
1991 Empire	G.41	99 NS	123 NS	---
1993 Liberty	G.41	90 *	125 *	---
1996 Gala	G.41	150*	124*	109*
1996 Empire	G.41	290*	0.87NS	101 NS
1998 Jonagold	G.41	96 NS	155 *	93 *
1999 McIntosh	G.41	126 NS	124 NS	105 NS
1999 Fuji	G.41	105 NS	112 NS	102 NS

Performance of G.41 in France

(Masseron and Simard, 2001)

- **Tree size was 20% smaller than M.9Pajam2 at 2 sites.**
- **Productivity was 9% greater than M.9Pajam.**
- **Fruit size was similar to M.9Pajam2.**

G.16

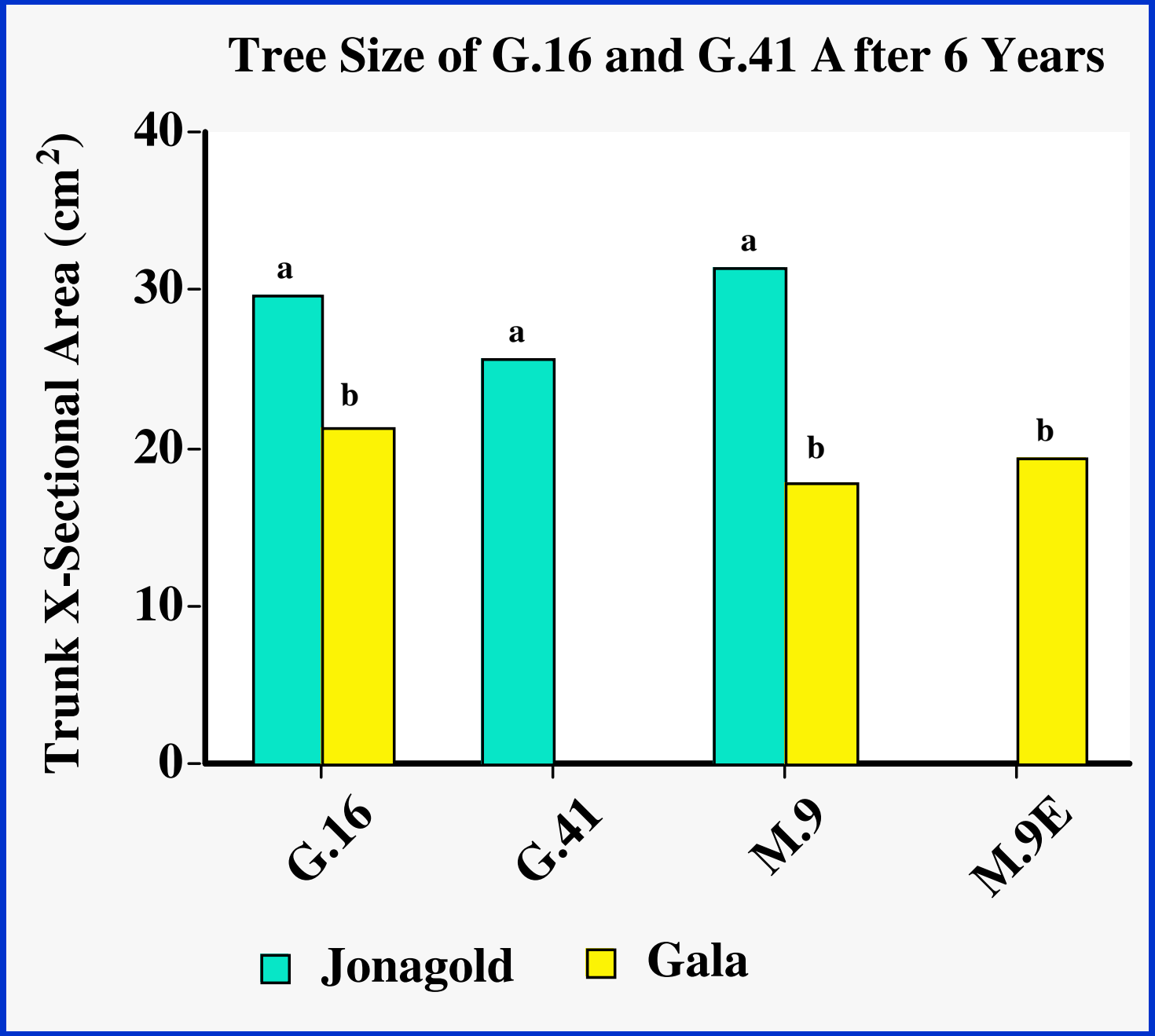
- Tree size and productivity are similar to M.9.
- It propagates well in the stoolbed and produces a large nursery tree.
- It is essentially immune to fire blight.
- It is tolerant of replant disease.
- It is sensitive to latent viruses which requires virus free budwood.
- If grown vigorously in the nursery it may be sensitive to early winter freeze events.
- As a cropping tree it survived the winter of 2003 better than M.9.

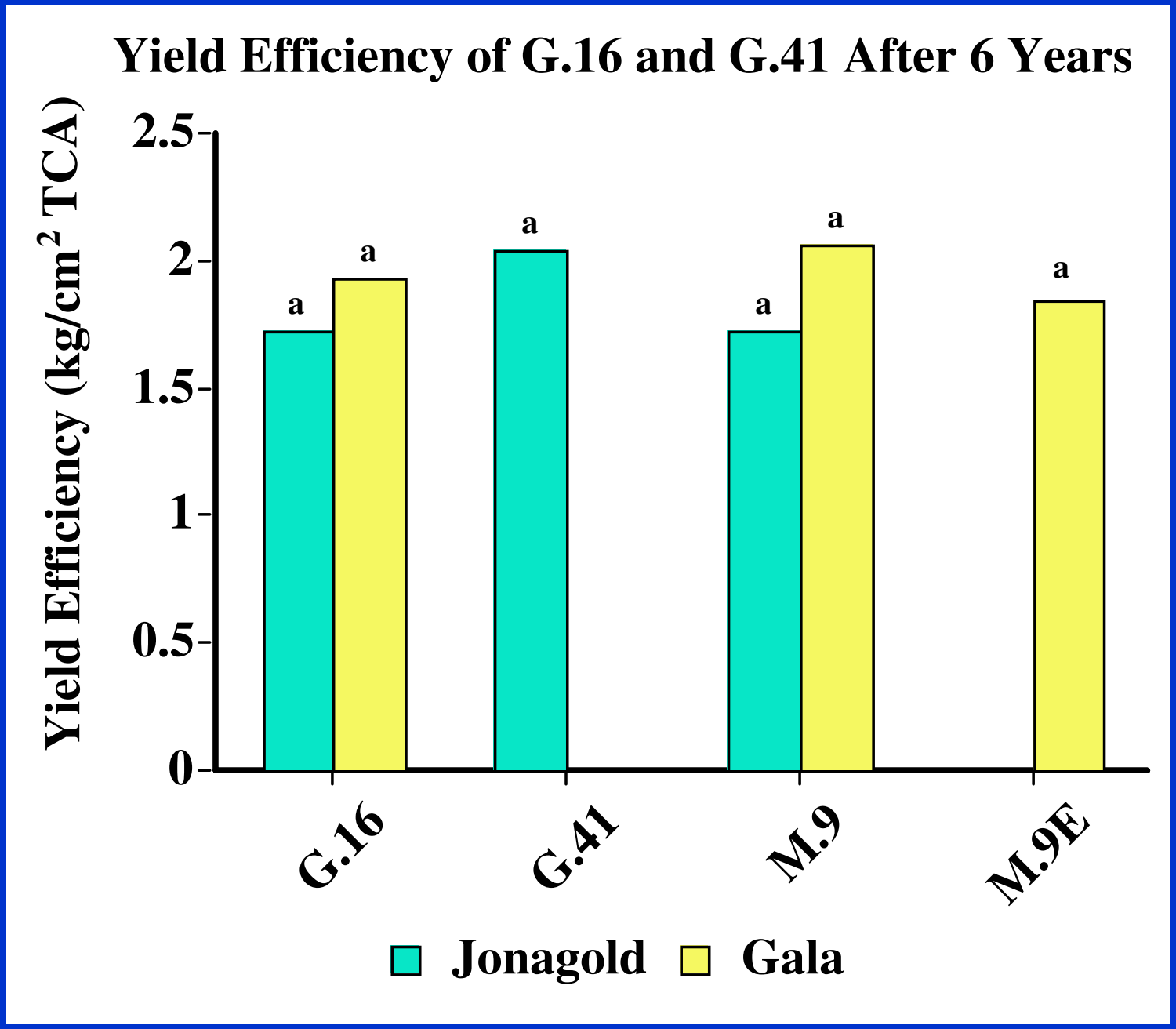
Performance of G.16

Trial	Rootstock	TCA (% of M.9)	Yield Eff. (% of M.9)	Fruit Size (% of M.9)
1998 Jonagold	G.16	91 NS	117 NS	91 *
1998 Gala	G.16	113 *	111 NS	92 *
1999 McIntosh	G.16	113 NS	131 NS	92 NS
1999 Fuji	G.16	124 *	107 NS	104 NS

Survival of Honeycrisp and McIntosh on Different Rootstocks After the Severe Winter of 2004

Rootstock	% Live Trees	
	Honeycrisp	McIntosh
Ottawa 3	100 a	-
G.30	92 ab	100 a
Mark	92 ab	96 a
G.16	92 ab	92 ab
M.9 T337	86 abcd	36 cd
B.9	66 bcde	37 cd
M.9 Nic29	55 cdef	58 bc
M.26	39 ef	26 cd
M.9/MM.111	36 ef	34 cd
MM.111	32 fg	38 cd
M.7	24 fg	31 cd
MM.106	0 g	17 d


Tree Size of G.16 and G.41 After 6 Years
Trunk X-Sectional Area (cm²)
40
30
20
10
0
a
b
a
b
a
b
b
G.16
G.41
M.9
M.9E
Jonagold
Gala


Yield Efficiency of G.16 and G.41 After 6 Years
Yield Efficiency (kg/cm2 TCA)
2.5
2
1.5
1
0.5
0
a
a
a
a
a
a
G.16
G.41
M.9
M.9E
Jonagold
Gala

G.41 **G.16** **G.41** **M.9**

Performance of G.11, G.16 and G.41 in European CG Rootstock Trial (7 locations)

	% of M.9T337	
Rootstock	Tree Circ	Yield Efficiency
M.9T337	100	100
M.9Pajam 2	118	90
G.16	115	80
G.41	123	99
G.11	119	117
G.202	134	81
CG.4013	140	74

Tolerance of G.11, G.16 and G.41to Fire Blight Inoculation and Natural Infection.

(Norelli, et al. 2002)

	% Tree Death due to Fire Blight	
Rootstock	Inoculation	Natural Infection
M.9	91	95
M.26EMLA	100	93
MM.111EMLA	8	15
M.7EMLA	--	31
G.16	0	0
G.41	0	0
G.11	25	25

G.935

- Vigor is intermediate similar to M.26.
- It is resistant to fire blight and crown rot.
- In NY it has been the best semi-dwarf rootstock in every trial.
- It has good propagation characteristics in the stoolbed.
- It appears to have good graft union strength
- We have released G.935 in the USA in Feb. 2005.

Performance of G.935

Trial	Rootstock	TCA (% of M.9)	Yield Eff. (% of M.9)	Fruit Size (% of M.9)
1991 Empire	CG.935	138 *	122 NS	---
	M.26	150 *	83 *	---
1998 Gala	G.935	207 *	112 *	101 NS
	M.26	162 *	76 *	110 *
1999 Fuji	G.935	144 *	1.09 NS	99 NS
1999 McIntosh	G.935	177 *	1.11NS	95 NS

G.202

- It is similar in size to M.26.
- It is resistant to woolly apple aphid, fire blight, and crown rot.
- In NY it has been a superior rootstock but not the top performer.
- In New Zealand it has been a top performer.
- Geneva ® 202 was released in May of 2002 in New Zealand. And in the USA in 2004.
- Partial tolerance to apple replant disease.
- Moderate rooting in stoolbed.

Performance of G.202

Trial	Rootstock	TCA (% of M.9)	Yield Eff. (% of M.9)	Fruit Size (% of M.9)
1991 Empire	G.202	153 *	101 NS	---
1991 Empire	M.26	150 *	83 *	---
1998 Gala	G.202	93 NS	86 NS	90 *

Trial	Rootstock	TCA (% of M.26)	Yield Eff. (% of M.26)	Fruit Size (% of M.26)
1996 Delicious	G.202	171 *	103 NS	108 *

Performance of G.202 in New Zealand

(Tustin and White)

- **Tree size was similar to M.26.**
- **Productivity was 5 % greater than M.26 on virgin soil but 26% greater than M.26 on replant soil.**

G.30

- Tree size is similar to M.7 in the early years but is closer to M.26 in later years.
- Very fire blight resistant.
- Tolerant to replant disease. (Merwin, 2000).
- Wide climate and soil adaptability.
- Winter hardy.
- Has a weak graft unions with brittle varieties during the early years.

Performance of G.30

Trial	Rootstock	TCA (% of M.9)	Yield Eff. (% of M.9)	Fruit Size (% of M.9)
1991 Empire	G.30	191 *	101 NS	---
1992 Liberty	G.30	177 *	116 NS	106 NS
Trial	**Rootstock**	**(% of M.26)**	**(% of M.26)**	**(% of M.26)**
1993 Liberty	G.30	120 *	134 *	---
1994 Gala	G.30	98 NS	138 *	97 NS
1996 Delicious	G.30	192 *	145 *	95 NS
1999 Fuji	G.30	117 NS	144 *	101 NS
1999 McIntosh	G.30	151 *	119*	96 NS

Performance of G.30 in French Trials

(Masseron and Simard, 2001)

1) Tree size was similar in size to M.9Pajam2 at 2 sites.

2) Productivity was similar M.9Pajam.

3) Fruit size was smaller than M.9Pajam2.

Where Does G.30 Fit?

1. Northern climates where M.9 are M.26 are too weak.
2. With weak growing scions such as spur type Delicious.

- Cautions:
  - Be careful with Gala, Golden, Honeycrisp, Jonagold Braeburn due to brittle graft union.
  - We recommend a 2 wire trellis with all G.30 plantings.

Geneva® Rootstocks

M.27 Size	M.9 Size	M.26 Size	M.7 Size
G.65	G.11	G.935	G.30
	G.41	G.202	
	G.16		