

Geneva® 935 A New Fire Blight Resistant, Semi-Dwarfing Apple Rootstock

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ABSTRACT

The Geneva® Apple Rootstock Breeding program which was initiated in 1968 by Dr. James Cummins and Dr. Herb Aldwinckle of Cornell University and which has been continued as a joint breeding program with the United States Department of Agriculture (USDA-ARS) since 1998, has produced a new semi-dwarfing apple rootstock which is named Geneva® 935 or G.935. G.935 (a progeny from a 1976 cross of 'Ottawa 3' X 'Robusta 5') is a selection that has been widely tested at the New York State Agricultural Experiment Station in Geneva, NY, in commercial orchards in the US and at research stations across the USA and Canada. G.935 is a semi-dwarfing rootstock that produces a tree slightly larger than M.26. G.935 is the most precocious and productive semi-dwarfing rootstock we have released. It has had similar yield efficiency to M.9 along with excellent fruit size and wide crotch angles. It showed no symptoms of winter damage during the 1994 test winter in NY. G.935 is resistant to fire blight and *Phytophthora*, however it is susceptible to infestations by woolly apple aphids. G.935 has shown tolerance to replant disease complex in several trials. It has good propagation characteristics in the stool bed and produces a large tree in the nursery. G.935 has better graft union strength than M.9 but will require a trellis or individual tree stake in the orchard to support the large crops when the tree is young. G.935 will be a possible replacement for M.26. Suggested orchards planting densities with this rootstock are 1,500-2,500 trees/ha. It has been released for propagation and sale by licensed nurseries. Liners will be available in the near future.

ORCHARD PERFORMANCE

Geneva® 935 or G.935. G.935 has been widely tested at the New York State Agricultural Experiment Station in Geneva, NY, in commercial orchards in the U.S. and at research stations across the U.S. and Canada. G.935 is a semi-dwarfing rootstock that produces a tree slightly larger than M.26. G.935 is the most precocious and productive semi-dwarf rootstock we have released. It has had similar yield efficiency to M.9 along with excellent fruit size and wide crotch angles. It showed no symptoms of winter damage during the 1994 test winter in NY. G.935 is resistant to fire blight and *Phytophthora* crown rot, however it is susceptible to infestations by woolly apple aphids. This rootstock has shown some tolerance in replant situations.

Table 1. Ten year performance of Empire apple on elite CG rootstocks in several on-farm trials in New York State.

Rootstock*	Trunk Cross Sectional Area Increase (% of M.9)	Fruit Number	Cumulative Fruit Yield (% of M.9)	Cumulative Yield Efficiency (% of M.9)	Average Fruit Size (% of M.9)	Cropload Adjusted Fruit Size (% of M.9)
CG.2077	17	48	43	228	90	94
G.65	58	63	60	111	94	94
Mark	66	93	95	142	102	103
CG.3041	99	119	119	123	101	101
M.9	100	100	100	100	100	100
G.935	138	176	171	122	97	98
M.9/MM.111	147	98	100	73	101	100
M.26	150	114	116	83	101	101
CG.4202	153	138	143	101	103	103
CG.88	186	158	160	85	101	100
CG.6210	191	199	196	104	99	99
G.30	191	185	181	101	98	98
CG.222	203	201	197	97	99	98
CG.7707	229	207	203	92	99	99
CG.4013	232	177	167	76	94	94
M.7	276	126	130	46	103	102
CG.103	362	205	193	53	95	93
LSD p<0.05	48	38	38	25	5	5

*Rootstocks ranked by final trunk cross sectional area



Table 2. Performance G.935 apple rootstock several NC-140 trials across the US and Canada.

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 *	1.11 NS	95 NS

DISEASE RESISTANCE

Rootstock resistance to fire blight (*Erwinia amylovora*) is tested in the greenhouse as apple rootstock liners are inoculated with a different virulent strains of the bacteria. Necrotic lesions are then measured for each liner and adjusted to the shoot growth of the liner. In the field scions budded on fire blight susceptible rootstocks will eventually die (girdled) whereas scions on resistant rootstocks will require simple pruning of affected branches as needed.

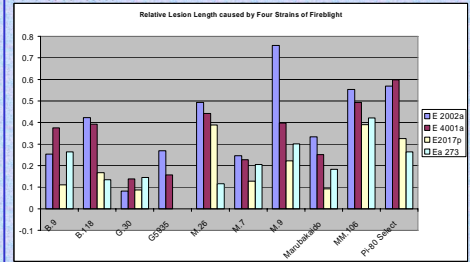
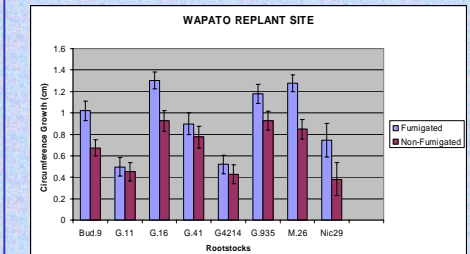


Figure 1. Means of relative necrotic lesions (cm lesion/cm liner) for several liners and experimental apple rootstocks.



Apple Replant Disease can cause severe production losses in an orchard as exemplified in the above graph which compares the growth of trees in non treated soil (to the growth in fumigated soil). B.9, M.26, G.16 and M.9 (Nic 29) show the greatest difference in tree growth between treatments. Geneva 935 is seen more tolerant than controls.

IMPORTANT POINTS ABOUT G.935

- Vigor is intermediate between M.26-M.7.
- It is resistant to fire blight and crown rot and shows tolerance to replant disease. It is not resistant to woolly apple aphids.
- In NY it has been the best semi-dwarf rootstock in every trial.
- It has good propagation characteristics in the stool bed.
- It appears to have good graft union strength

NURSERY PERFORMANCE

The stool bed productivity (liners/meter) of Geneva 935 is about 90 % of M.26 EMLA. Rooting capacity is consistent in different nurseries in the U.S. Some spines are present in very young stool beds.



Trilled liners of Geneva 935 in a nursery in Washington State. Geneva 935 has been budded in several nurseries in the U.S. and abroad. Transplant survival of #1 liners is above 90%. In the nursery, grafted and budded trees on G.935 display similar growth to trees budded on M.26.



References:

Robinson, T. L., Anderson, W., Aulisio, B., Barritt, J., Cline, R., Craswell, W., Cowgill, C., Embree, D., Ferree, E., Garcia, G., Greene, C., Hampton, K., Kozola, M., Parker, R., Perry, T., Roper, and M. W. Warming. 2005. A multi-location comparison of Geneva 16, Geneva 41 and M.9 apple rootstocks across North America. *Acta Hort.* (in press)

Aulisio, W., L. Anderson, B. Barritt, J. Cline, R. Craswell, C. Embree, D. Ferree, E. Garcia, G. Greene, E. Hoover, S. Johnson, K. Kozola, J. Masabni, M. Parker, R. Perry, G. Reighard, T. Robinson. 2005. Early performance of Fuji and McIntosh apple trees on several elite rootstocks in the 1999-NC-140 rootstock trial. *Acta Hort.* (in press)

Aulisio, W., L. Anderson, A. Azarenko, B. Barritt, G. Brown, J. Cline, R. Craswell, P. Domoto, C. Embree, A. Fennell, D. Ferree, E. Garcia, G. Greene, C. Hampton, P. Hirst, E. Hoover, S. Johnson, M. Kuschal, R. Marini, R. Moran, C. Mullins, M. Parker, G. Reighard, R. Perry, J.P. Prive, C. Rom, T. Roper, J. Schupp, M. Warming, W. Auto, W. Coughl, K. Taylor, D. Wolfe. 2004. Performance of Cornell-Geneva Rootstocks in Multi Location NC-140 Rootstock Trials Across North America. *Acta Hort.* 628:241-245

Robinson, T. L. and S.A. Hoyley. 2004. Performance of elite Cornell-Geneva apple rootstocks in long-term orchard trials on growers farms. *Acta Hort.* 628:221-229

Robinson, T. L., H.S. Aldwinckle, G. Fazio and T. Hollieran. 2003. The Geneva series of apple rootstocks from Cornell: Performance, disease resistance, and commercialization. *Acta Hort.* 622:513-520

Robinson, T. L., Anderson, A., Azarenko, B., Barritt, G., Brown, G., Couston, W., Cowgill, R., Craswell, R., Domoto, C., Embree, A., Fennell, E., Garcia, A., Gaus, R., Granger, G., Greene, P., Hirst, E., Hoover, S., Johnson, M., Kuschal, R., Moran, C., Mullins, S., Myers, R., Perry, C., Rom, J., Schupp, K., Taylor, M., Warming, J., Warner, and D. Wolfe. 2003. Performance of Cornell-Geneva apple rootstocks with Liberty as the scion in NC-140 trials across North America. *Acta Hort.* 622:521-530

Norrell, J.L., H.T. Hollieran, W.C. Johnson, T.L. Robinson, and H.S. Aldwinckle. 2003. Resistance of Geneva and other apple rootstocks to *Erwinia amylovora*. *Plant Disease*. 87(1):26-32

Norrell, J.L., H.S. Aldwinckle, H.T. Hollieran, T.L. Robinson and W.C. Johnson. 2002. Resistance of 'Geneva' apple rootstocks to *Erwinia amylovora* when grown as potted plants and orchard trees. *Acta Hort.* 592:359-363

Robinson, T., G. Fazio, and H. Aldwinckle. 2005. High-density orchards, dwarfing rootstocks more popular. *The Fruit Grower News*. 42 (2): 24-27

Robinson, T., G. Fazio, H. Aldwinckle, S. Hoyley, K. Jurgensman, and M. Fargione. 2004. Where do the Geneva® apple rootstocks fit in New York state? *NY Fruit Quarterly* 12(4):3-6

Robinson, T., G. Fazio, H. Aldwinckle and S. Hoyley. 2004. Performance of the new Geneva® apple rootstocks in trials in the U.S., NZ and Europe. *Compact Fruit Tree* 3(3): 41-46

Robinson, T., S.A. Hoyley, M. Fargione, and K. Jurgensman. 2003. On-farm trials of the Cornell-Geneva apple rootstocks in New York. *Compact Fruit Tree* 3(3):70-73

Robinson, T.L. 2003. Rootstocks as a key component to high density orchards. *Compact Fruit Tree* 3(3):Special issue#9-13

Robinson, T. L., Anderson, A., Azarenko, B., Barritt, G., Brown, J., Cline, R., Craswell, P., Domoto, C., Embree, A., Fennell, D., Ferree, E., Garcia, A., Gaus, G., Greene, C., Hampton, P., Hirst, E., Hoover, S., Johnson, M., Kuschal, R., Marini, R., Moran, C., Mullins, M., Parker, R., Perry, J.P., Prive, G., Reighard, C., Rom, T., Roper, J., Schupp, M. Warming. 2002. Performance of Cornell-Geneva Rootstocks in the Multi Location NC-140 Rootstock Trials Across North America. *Compact Fruit Tree* 3(4):99-102