Apple Rootstock Trials in British Columbia, Canada

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The AAFC research centre at Summerland, B.C., has long been a participant in the USDA NC-140 series of collaborative uniform trials of rootstocks (www.nc140.org). These trials are a useful way of acquiring new rootstocks to try, and generating practical site-specific data on performance. There are many locations in the trials, each with its own set of production challenges, which helps to identify rootstock strengths and weaknesses more quickly. A recent example is the detection of brittle graft unions with some rootstocks, when high winds associated with a passing hurricane hit some trial sites in the southeastern USA. Certain locations have frequent episodes of fire blight or winter damage, and their reports yield useful information to the whole group.

In B.C., growers are chiefly interested in dwarf and semi-dwarf trees to suit high density plantings such as super spindle orchards. We wish to find a rootstock with all the good traits of M.9, but with more resistance to fire blight and replant syndrome, and ideally greater winter hardiness.

This talk reports the findings from the Summerland site for the NC-140 apple trials planted in 2002 and 2003. In addition, two small independent rootstock trials are described: a trial of four Vineland rootstocks (bred at AAFC in Vineland many years ago), and a trial of five Quebec rootstocks that were released by Dr. S. Khanizadeh from AAFC at St.-Jean-sur-Richelieu.

The 2002 NC-140 trial had ‘Buckeye Gala’ as the scion on 10 rootstocks, and the 2003 trial tested 18 rootstocks with ‘Golden Delicious’ as the scion. In both of these trials, the trees were trained as vertical axes, supported by a post-and-wire trellis. Irrigation and sprays followed local commercial practices. The trees were de-fruited in their second leaf to encourage tree growth and prevent stunting. In later years, the trees were spray thinned at bloom or (in some years) at the young fruitlet stage. Follow-up hand thinning was done to achieve a suitable crop load, generally spaced as one fruit per 15 cm of branch length, in single-fruit clusters. Thinning was normally completed before July. The rootstocks in these trials were sourced from a variety of countries, including the USA (Geneva rootstocks), Germany (Pi Au and Supporter rootstocks), Poland, Russia (Budagovsky rootstocks), the Czech Republic (“J-TE-“ series) and Japan (Morioka rootstocks). Standards were M.9 and M.26. Sub-clones of M.9, M.26 and B.9 from different source nurseries or programs were also tested to see if they differed significantly. The final results (after 10 growing seasons) from these trials are shown in Tables 1 and 2. The small trial of Vineland rootstocks was planted in 2003. It was managed in the same way as the two NC-140 plantings, but we propagated the trees in

our nursery, and the scion was Aurora Golden Gala™. The Vineland rootstock trial was ended after 8 growing seasons, with the results shown in Table 3.

The Quebec rootstock trial was handled slightly differently. Dr. Khanizadeh sent us some rootstock liners grown in a greenhouse from plants originally produced in tissue culture. Originally there were 10 plants of each rootstock. We transplanted them to our field nursery but there was some mortality over the next couple of years. The rootstocks were grown in the nursery for an extra year to achieve a size that could be budded. 'Royal Gala' was chosen as the scion cultivar. Six to seven surviving trees per rootstock (SJM-15, SJM-189, SJP 84-5198, SJP 84-5218) were planted in 2009, along with two standards (M.9-T337, B.9). They were trained as slender spindles with treated posts for support. Only one tree on SJM-150 survived. It was planted for observation but not included in the statistical analysis. Other management practices were as already described. It is too early for reliable conclusions from this trial, but for all three cropping years so far, we have found the fruit of trees on SJM-189 to have better color than the other trees. Internal fruit maturity appears no different. At present, the trees of SJP 84-5198 and SJP 84-5218 are significantly larger than those on M.9 or B.9, as estimated by trunk cross-sectional area.

The B.C. results for the three completed trials are summarized below by vigor category. Note that rootstock performance varies quite a lot from location to location. The results from other test sites can be viewed at the NC-140 web site (www.nc140.org). For commercial use, it is always wise to do one's own small test planting when trying a new rootstock, before making a significant investment. Management and site factors can affect the rootstock performance in ways that are not always easy to predict.

Rootstocks more vigorous than M.26

Trees on Pi 56-83, Pi 51-4, JM.2, P.14 and V.4 were significantly larger than trees on M.26. Supporter 4 may also be in this category. Average trunk cross-sectional area (TCSA) of Supporter 4 was bigger than M.26 but the difference was not statistically significant. All these rootstocks had low cumulative yield efficiency (CYE). Trees on both Pi stocks and JM.2 had good survival, low suckering, and good fruit size. With P.14 and Supporter 4, suckering was low and fruit size was good, but greater rates of tree mortality occurred. P.14 was also slow to come into bearing (low precocity). Tree survival on V.4 was good, but these trees also had low precocity, moderate suckering, and smaller fruit size.

Rootstocks with vigor similar to M.26 or slightly smaller

The rootstocks CG.6210, J-TE-H, CG.5935, Pi 51-11, V.1 and V.2 all produced trees similar in size to those on M.26. Some (but not all) of the trees on CG.6210, CG.5935, Pi 51-11 and J-TE-H produced quite a few suckers. CG.5935 had very good yield and yield efficiency, being significantly better than M.26 in these respects. This rootstock has been commercially released as Geneva 935. It is said to be resistant to woolly apple aphids and

fire blight, tolerant to replant and crown/root rot, and cold hardy. V.1 and V.2 reduced fruit size slightly, but they had low suckering and otherwise performed well in our trial.

JM.7 and JM.8 trees were intermediate between M.9 and M.26 in vigor. JM.8 cannot be recommended due to poor survival, and survival was only moderate for JM.7.

Rootstocks with vigor similar to M.9

Rootstocks producing trees similar to M.9 in size included CG.3041, G.16, B.62396, V.3, B.9 and M.9 sub-clones. The best new ones in our experience were CG.3041 and B.62396, which had good survival, high efficiency and possibly fewer root suckers than trees on M.9-T337. CG.3041 has been commercially released as Geneva 41. It is said to be resistant to woolly apple aphids and fire blight, tolerant to replant and to crown/root rot, and cold hardy. V.3 was also good in most respects but it reduced fruit size slightly. Trees on G.16 had greater losses from tree mortality, and they also had smaller fruit, lower CYE and more suckering than M.9 in some cases. Trees on the M.9 sub-clones Pajam 2 and Nic 29 had an undesirable degree of suckering, but they were otherwise similar to M.9-T337 in performance. (These two had larger trees on average than T337, but the difference was not statistically significant.)

Although trees on B.9 had high CYE, they became stunted out, with insufficient new growth and a trend to smaller fruit size and lower cumulative yield. The problem was not a lack of water, because all trees were irrigated. We have had variable results with B.9 in trials over the past couple of decades at the Summerland research station. On good soil, the trees can be slightly larger than those on M.9, but on coarse soils, they seem to lack sufficient vigor. Local growers have likewise found variable responses with B.9.

Rootstocks with less vigor than M.9

Rootstocks JM.1 and J-TE-G both produced trees significantly smaller than M.9, and too small to be of commercial interest in our region. Although trees on J-TE-G were too dwarfed (similar to M.27 in size), they had virtually no suckering, and their survival and CYE were both superior to trees on JM.1. M.27 is known for inducing smaller fruit size on the scion than M.9, but J-TE-G had good fruit size. It would be worthy of testing if a very small tree was desired.

Sub-clones of M.9, B.9 and M.26

The two sub-clones of B.9 were statistically similar to each other in all respects, except that those on B.9 Europe seemed to produce more suckers. Likewise the two M.26 sub-clones were not different from each other. Among the M.9 sub-clones, performance did not differ greatly. Nic 29 and Burgmer 756 may produce marginally larger trees than M.9-T337, and Nic 29 and Pajam 2 had a greater propensity for suckering. All had good CYE, fruit size and yield.

Table 1. Growth of 'Buckeye Gala' on various rootstocks at Summerland, 2011. Trees were planted in 2002. Mean separation within columns is by Waller-Duncan K-ratio t test, K-ratio=100. Rootstocks are sorted in descending order of TCSA. Standard stocks are in boldface type.

Rootstock	TCSA (cm^2)	Range in cumu. no. of suckers/tree	Cumulative yield to 2011 (kg/tree)	CYE (kg/cm^2 TCSA)	Survival[z]	Average fruit weight 2005-11 (g)
JM.2	91.1 a	0 to 13	249.2 a	2.77 e	4/4	188 a
P.14	76.2 b	0 to 10	237.3 ab	3.09 de	5/7	195 a
Supporter 4	60.3 c	0 to 12	205.8 bc	3.53 cd	4/7	188 a
M26 EMLA	**49.8 cd**	**0 to 10**	**181.7 cd**	**3.67 bcd**	**6/7**	**186 a**
M.9-B756	46.4 de	0 to 25	193.4 c	4.27 b	7/7	197 a
M.26-NAKB	43.9 de	0 to 9	184.8 cd	4.03 bc	7/7	191 a
M9-Nic29	43.1 de	0 to 85	179.4 cd	4.24 b	7/7	194 a
M.9-T337	**36.9 def**	**10 to 30**	**181.9 cd**	**5.06 a**	**6/7**	**196 a**
B.9-Treco	34.2 ef	1 to 15	187.1 c	5.51 a	5/7	189 a
B.9-Europe	29.1 f	10 to 45	145.0 d	5.09 a	7/7	191 a

[z]Number of living trees/number of trees planted.

Table 2. Performance of 'Golden Delicious' on 18 dwarf and semi-dwarf rootstocks at Summerland, 2012. The trees were planted in 2003. Mean separation within columns is by Waller-Duncan K-ratio t test, K-ratio=100. Standard stocks are in boldface type. Rootstocks are sorted in descending order of TCSA.

Rootstock	TCSA (cm^2)	Survival[z]	Cumulative yield to 2012 (kg/tree)	CYE (kg/cm^2 TCSA)	Average fruit weight 2006-12 (g)	Range in cumulative no. of root suckers/tree
Pi 56-83	134.8 a	7/8	211.3 bcd	1.63 h	237 abcd	0 to 10
JM.2	133.8 a	7/8	250.6 ab	1.93 h	247 a	0 to 27
Pi 51-4	128.3 a	7/7	271.1 a	2.15 h	246 ab	0 to 48
J-TE-H	55.6 b	8/8	187.6 cde	3.49 g	234 cde	9 to 69
CG.6210	54.8 bc	6/7	211.4 bcd	3.98 fg	242 abcd	44 to 111
M.26	**54.3 bcd**	**8/8**	**208.5 bcd**	**4.05 fg**	**237 abcd**	**0 to 13**
CG.5935	50.3 b-e	7/7	249.1 ab	4.96 cde	238 abcd	15 to 116
Pi 51-11	50.2 b-e	7/8	169.5 cdef	3.64 g	231 def	17 to 176
JM.7	47.4 b-f	5/7	201.7 cde	4.27 d-g	237 abcd	0 to 17
CG.3041	45.3 b-f	7/8	213.9 bc	4.77 c-f	244 abc	0 to 20
G.16	40.6 c-f	5/8	155.4 ef	3.82 g	224 ef	8 to 112
JM.8	39.7 b-f	3/6	164.3 def	4.11 efg	222 f	7 to 50
M.9 Paj2	**38.4 ef**	**8/8**	**176.9 cde**	**4.74 c-f**	**237 abcd**	**22 to 101**
B.62396	35.6 efg	7/8	185.3 cde	5.25 bc	243 abc	1 to 41
M.9-T337	**33.5 fg**	**7/8**	**159.7 ef**	**5.04 cd**	**235 bcde**	**13 to 77**
B.9	**21.3 gh**	**8/8**	**123.7 fg**	**6.07 ab**	223 ef	**25 to 106**
J-TEG	15.3 h	6/7	97.0 gh	6.52 a	244 abc	0 to 1
JM.1	12.8 h	3/7	65.0 h	5.38 bc	206 g	0 to 9

[z]Number of living trees/number of trees planted.

Table 3. Performance of Aurora Golden Gala™ on 5 rootstocks at Summerland, 2010. The trees were planted in 2003. Mean separation within columns is by Waller-Duncan K-ratio t test, K-ratio=100. Rootstocks are sorted in descending order of TCSA. The standard rootstock is in boldface type.

Rootstock	TCSA (cm^2)	Survival[z]	Cumulative yield to 2010 (kg/tree)	CYE (kg/cm^2 TCSA)	Average fruit weight 2005-10 (g)	Range in cumulative number of root suckers/tree
V.4	93.4 a	6/6	173.2 a	1.90 c	203 b	22 to 55
V.2	45.0 b	6/6	142.9 b	3.18 b	204 b	0 to 23
V.1	43.5 b	6/6	132.6 bc	3.15 b	202 b	0 to 23
V.3	27.7 c	6/6	124.2 c	4.52 a	213 b	0 to 11
M.9 T337	**26.2 c**	**6/6**	**128.8 bc**	**4.97 a**	**225 a**	**1 to 46**

[z]Number of living trees/number of trees planted.