

The Origin and Development of the KSC Apple Rootstocks

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Abstract

The origin and development of 30 hardy Kentville Stock Clone (KSC) selections is recounted and field performance of 'McIntosh' and 'Red Delicious' scion cultivars on these stocks is presented. A phenology of the KSC rootstocks is documented and compared to certain other rootstocks.

Introduction

Prior to the middle of this century the most widely used apple rootstocks in Eastern Canada and much of North America were seedlings of "French crab" or domestic apples. In the 1960's commercial plantings shifted to clonal stocks such as M.26, M.7, MM.106, MM.111 (England), Alnarp (Sweden), *Malus robusta* No. 5 (Canada) or Beautiful Arcade seedlings (Canada).

Apple growers in the Province of Nova Scotia made the greatest use of Beautiful Arcade (BA) whereas *Robusta* No. 5 (R5) was widely adopted in New Brunswick. Commercial acceptance of BA seedlings was promoted by reports of high productivity (1), hardiness (5), and uniformity (8); R5, by an exhibition of superior hardiness following snow removal experiments at Ottawa (6).

Propagation stock for BA came from a seed orchard established in 1948 at the Agriculture Canada Research Station, Kentville with Antonovka as a pollinator.

Tree losses in orchards planted since the 1960's were variable but in some cases extensive; primarily as a result of breakage at the graft union and collar rot in Nova Scotia and canker and

winter injury in New Brunswick. While trees on BA seedlings in Nova Scotia were not totally immune to mortality they demonstrated more reliable performance than trees on other stocks especially with 'McIntosh' and 'Cortland'. In New Brunswick, trees on R5 did not demonstrate superior scion hardiness (2) and McIntosh trees on this stock were particularly susceptible to European canker, *Nectria galligena*.

This paper documents the origin, development and early performance of 30 BA seedling selections as rootstocks for 'McIntosh' and 'Red Delicious' and compares their phenology with other rootstocks.

Materials and Methods

The Kentville Stock Clones (KSC) apple rootstocks were selected from Beautiful Arcade seedlings with Antonovka as the primary pollen source (3). The hardiness selection occurred in a New Brunswick nursery where only 30 of the initial planting of 9000 seedlings fully survived the 1969-70 winter. Winter conditions had not been unusual until the first twelve days of February when temperatures were above freezing for ten days, the maximum being 12.8°C on Feb. 3rd and 4th. The last nine days of the month, the minimum temperature each day was below -19°C and to a maximum low of -28.3°C on Feb. 27th. The thirty seedling survivors were brought to Kentville and vegetatively propagated by layering for evaluation and further development.

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Rootstock Phenology Study

Ungrafted, rooted layers of the 30 KSC clones, were planted in 1973 as part of a rootstock specimen collection and arranged in groups of five trees each at a spacing of 1.6 m x 5.6 m with 3.2 m between selections. The site is reasonably uniform but has a dense sub-soil. No pruning or rootsucker removal was practiced. The trunk cross sectional area was determined from a measure of the trunk girth at 30 cm above ground in Aug. 1985. Root suckers were counted in the spring of 1985. The timing for spring bud break was observed and records taken of bud development through bloom in 1984 and 1985. Leaf drop was recorded over a six week period during the fall of 1982 and 1985. The phenology response of certain other apple rootstocks in adjacent rows were included for comparison even though of a different age.

Scion Rootstock Performance Study

In the spring of 1978, 'Blackmac McIntosh' and 'Starking Red Delicious' trees, both propagated from virus-indexed stocks on the 30 selections as 1-year whips, were established in a randomized complete block design with five replications at a spacing of 4.3 x 6.1 m, 383 trees/ha (14' x 20', 155 trees/acre). Fruit yield and trunk girth were recorded annually.

Results and Discussion

Rootstock Phenology Study

The 30 rootstock selections in the specimen planting exhibited considerable uniformity in growth within a particular clone. Vigor and tree form differences between the 30 clones was considerable (Table 1). Selection KSC-28 exhibited the greatest vigor control and the adjacent clone, KSC-29 the least. Tree form varied: KSC-26 is very bushy, shrub-like in appearance and not as tall as KSC-28; KSC-13, by contrast, is very tall with upright form.

Root suckering was encouraged by herbicide practices that controlled all vegetation leaving the ground without cover. In this situation large roots were partially bare at the time of recording. The KSC stocks 2, 3, 7, 8, 9, 10 and 17 have a tendency to produce root suckers but still less than M.7. The KSC clones 6, 13, 15, 16, 21, 22, 25, 28 and 30 are almost free of this trait.

Timing of spring bud break in ungrafted rootstocks can range over a 4-week period (4). An early bud break tendency transmitted to the scion could be an important consideration in areas where spring frost is a problem. It may also be very important in apple growing regions subject to periods of warm weather during winter. Gollmick (7) found winter damage was greatest in clones that begin bud break early. It was noted that R5 was one of the earliest rootstocks to grow in the spring. Certain KSC selections also display this characteristic, namely 1, 3, 4, 5, 7, 10, 11, 13, and 16. Those slow to respond to warming trends in the spring were 18, 19, 22, 29 and 30, however none of these were as slow as M.16.

Leaf drop timing in the fall could denote differences in acclimations. Certain selections initiated leaf drop early in the fall others are as much as six weeks later (Table 1). Early acclimation, a reflection of reduced cambial activity is considered very important in cultivar hardiness (9). This phenomenon may be restricted to the rootstock or it may be transmitted to the scion but results are inconclusive. These results do illustrate a wide variation within progeny of the same female parent.

Scion Rootstock Performance Study

The yield history, growth and yield efficiency of virus indexed 'Blackmac McIntosh' and 'Starking Red Delicious' apple trees on the 30 KSC rootstocks is given in Table 2. 'McIntosh' on rootstocks KSC 3, 11 and 28 were most precocious and have continued this

Table 1. Trunk size, root suckering, timing of spring bud break and fall leaf drop of certain apple rootstocks in an ungrafted specimen planting of thirteen years.

Rootstock	Trunk Size CM ^a	Root suckers No./tree	Phenological rating ^o	
			bud break	leaf drop
KSC 1	188 ±5.6	4 ±3.5	VE	ME
KSC 2	192 ±3.9	13 ±7.5	ME	VE
KSC 3	230 ±3.4	24 ±5.3	VE	ME
KSC 4	233 ±5.3	9 ±1.7	VE	ME
KSC 5	258 ±5.1	9 ±5.0	VE	E
KSC 6	178 ±3.2	1 ±1.1	ME	ME
KSC 7	219 ±3.8	17 ±7.1	VE	E
KSC 8	189 ±3.8	15 ±6.0	M	ML
KSC 9	214 ±0.2	14 ±2.0	M	ME
KSC 10	222 ±4.8	19 ±6.2	VE	E
KSC 11	158 ±3.4	7 ±5.0	VE	ME
KSC 12	122 ±3.5	6 ±3.3	E	ML
KSC 13	200 ±6.9	2 ±2.3	VE	E
KSC 14	178 ±4.2	5 ±1.9	ME	M
KSC 15	142 ±4.7	1 ±0.8	M	ML
KSC 16	119 ±4.6	1 ±1.2	VE	E
KSC 17	143 ±3.3	13 ±1.7	E	M
KSC 18	138 ±3.4	6 ±4.6	ML	E
KSC 19	151 ±3.6	11 ±3.7	ML	ML
KSC 20	186 ±2.8	9 ±3.3	M	ML
KSC 21	185 ±4.6	2 ±2.6	M	VL
KSC 22	104 ±7.4	1 ±7.5	L	E
KSC 23	155 ±3.7	33 ±3.6	M	E
KSC 24	172 ±3.6	6 ±2.6	E	E
KSC 25	110 ±5.8	1 ±1.0	M	M
KSC 26	128 ±5.5	11 ±6.7	E	M
KSC 27	220 ±6.4	3 ±2.3	M	M
KSC 28	88 ±1.2	18 ±1.9	M	E
KSC 29	282 ±2.5	6 ±4.0	ML	M
KSC 30	182 ±3.7	1 ±0.8	ML	M
MM.106	148 ±2.1	5 ±2.6	L	VL
MM.111	149 ±3.8	6 ±3.9	L	M
M.16**	262 ±5.0	1 ±1.2	VVL	—
M.7**	110 ±2.4	48 ±18.6	M	L
M.26**	— —	14 ±2.3	L	—
Robusta No. 5**	466 ±7.9	8 ±1.1	VE	M
Alnarp 2**	118 ±7.9	6 ±4.5	M	ML
†Beautiful Arcade	—	—	M	M

Means ± standard deviation adjacent trees.
^oRating: Very early (VE), Early (E), Medium early (ME), Medium (M), Medium late (ML), Late (L), Very late (VL), Very very late (VVL).
**Seventeen years old.
†Growing as a cultivar on a seedling rootstock in an adjacent orchard.

Table 2. Yield history, trunk size and efficiency of 'McIntosh' and 'Red Delicious' apple trees on 30 KSC rootstocks.

KSC root- stock	'McIntosh'						'Red Delicious'					
	Yield (kg/tree)			Trunk size 1984 (cm ²)			Yield (kg/tree)			Trunk size 1984 (cm ²)		
	1980	1981	1982	1983	1984	1980 to 1984	1982	1983	1984	1982 to 1984	1984	Yield effi- ciency (kg/cm ²)
1	1	7	25	76	107	217	5	37	35	77	90.4	0.9
2	0	4	12	70	108	193	8	35	46	90	106.8	0.8
3	3	11	53	105	140	312	14	41	62	117	111.7	1.1
4	1	4	20	79	79	184	7	30	32	69	78.7	0.9
5	0	5	27	95	108	243	6	42	40	88	113.1	0.7
6	0	7	33	106	167	313	11	33	55	99	87.4	1.2
7	1	10	31	97	127	265	13	45	64	121	95.9	1.3
8	0	4	14	53	100	172	8	27	51	87	86.4	1.0
9	1	1	11	41	96	151	6	38	44	88	100.0	0.9
10	0	7	25	79	114	225	7	35	35	77	100.5	0.8
11	2	11	34	79	124	249	18	48	80	146	93.9	1.6
12	1	4	26	68	134	233	10	36	64	110	95.7	1.2
13	0	5	20	79	135	239	13	42	64	119	105.5	1.2
14	0	1	4	32	44	80	3	8	7	18	43.9	0.4
15	1	4	47	72	136	245	13	25	30	69	71.9	1.0
16	1	2	14	44	100	163	9	32	51	92	84.8	1.1
17	1	6	20	92	129	248	14	53	63	135	102.7	1.3
18	1	5	20	49	58	132	9	23	31	63	57.2	1.0
19	0	2	11	59	97	162	5	22	38	65	81.1	0.8
20	0	1	12	59	90	162	2	27	16	46	88.1	0.5
21	1	3	24	80	114	222	11	33	56	100	92.3	1.1
22	0	4	18	53	86	161	5	24	41	70	84.5	0.8
23	0	1	15	45	85	146	8	23	34	65	67.0	1.0
24	1	6	23	77	107	218	20	56	69	146	92.6	1.5
25	1	7	29	62	106	195	14	40	48	103	87.4	1.2
26	0	2	12	38	43	95	6	74	23	102	69.3	1.6
27	0	4	17	61	115	197	6	30	28	64	85.8	0.7
28	3	8	23	57	47	138	21	28	68	117	61.2	1.9
29	0	3	18	45	95	161	5	26	24	55	85.9	0.6
30	0	4	23	51	85	168	10	28	41	78	80.4	1.0
S.E.M.						12.56				7.88	7.67	0.09

productive tendency. 'McIntosh' also yield well on KSC 1, 5, 6, 7, 10, 12, 13, 15, 17, 21 and 24. KSC-3 and KSC-6 demonstrate considerable vigor compared to those on KSC 28, 26 and 14. Yield efficiency is very high with KSC-3 and KSC-7. Many selections demonstrate high efficiency with the exception of KSC-14 which was a poor promoter of yield efficiency, even though it transmitted considerable vigor control.

'Red Delicious' was notably precocious on KSC 3, 11, 17, 24 and 28. Cumulative yields after 3 crops were amongst the highest on these same stocks but KSC 7, 12, 13, 21, 25 and 26 also produced heavy crops. KSC-14 induced the lightest yields in 'Red Delicious' of any combination. Trunk size of 'Red Delicious' was greatly influenced by the various rootstocks ranging from 111.7 cm² for trees on KSC-3 to 43.9 cm² for trees on KSC-14. Yield efficiency was greatest on trees with the rootstock KSC-28 and lowest on those with KSC-14. The rootstocks which promoted a yield efficiency of 1.5 and above were KSC 11, 24, 26 and 28.

'McIntosh' on the thirty KSC selections began cropping earlier and produced more total yield than 'Red Delicious.' Trunk size of these two cultivars on the respective rootstocks is surprisingly similar regardless of the yield history. Yield efficiencies are low in 'Red Delicious' compared to 'McIntosh'

but this is expected to change as the trees mature.

Summary

These preliminary assessments of the KSC apple rootstock series encourage us to continue the development of these potentially hardy, productive, and vigor-controlling selections.

References

1. Bligh, R. D. L. 1944. Our Apple Trees — Can their Growth and Productivity be Modified. N.S. Fruit Growers Association Annual Report 81: 31-39.
2. Crowe, A. D. 1975. Winter injury in apple and M. robusta 5 rootstock. Kentville Res. Sta. Ann. Rept. 51-52.
3. Crowe, A. D. and C. G. Embree. 1982. Hardy clonal selections of Beautiful Arcade Apple Seedlings. II: Identification changed to Kentville Stock Clone (KSC). Kentville Res. Stn. Ann. Rept. p. 24.
4. Cummins, J. N. and Alert, H. S. 1983. Rootstock Breeding. In: Methods in Fruit Breeding ed. James N. Moore and Jules Janick
5. Davis, M. B. 1947. Some problems in orchard management. N.S. Fruit Growers Assoc. Ann. Report 83: 28-35.
6. Davis, M. B. 1950. Progress Report (1934-1948). Hort. Div. Can. Agr. Res. Sta., Ottawa 259.
7. Gollmick, F. 1957. Beobachtungen über Frostscha den an Wildapfeln und Gihren Samlingen als Folge der strengen Frostperiode im Februar 1956. Arch. Gartenbau 6: 126-149.
8. Longley, R. P. 1960. The variability of trunk cross-sections and yields of Fameuse and McIntosh apple trees grown on three clonal and two seedling rootstocks. Proc. Amer. Soc. Hort. Sci. 76: 11-15.
9. Solovieva, M. A. 1974. Winter Hardiness of Fruit Plants. XIX Int. Hort. Congress. Warsaw. 93-104.