Development and Evaluation of St Jean-Morden Apple Rootstock Series

Shahrokh Khanizadeh, Yvon Groleau, Audrey Levasseur, and Raymond Granger

Agriculture and Agri-Food Canada, Research Station, 430 Boulevard Gouin, St-Jean-sur-Richelieu, QC, Canada J3B 3E6

Gilles L. Rousselle

Agriculture and Agri-Food Canada, 2560 Hochelaga Boulevard, Sainte-Foy, Quebec, G1V 2J3

Campbell Davidson

Agriculture and Agri-Food Canada, Cereal Research Centre, Unit 100–101 Route 100, Morden, MB, Canada, R6M 1Y5

Abstract. Two hundred and nine hybrid seedlings developed by crossing Nertchinsk × M.9, Osman × Heyer 12, and Nertchinsk × M.26 were evaluated since 1970 in Agriculture and Agri-Food Canada (AAFC), Horticultural Research and Development center (HRDC), Quebec, Canada. ‘McIntosh’ was used as the scion. Seven of these rootstocks obtained from crossing ‘Nertchinsk’ with M.9 and M.26 were found to be winter hardy, disease resistant, dwarfing, with good yield efficiency and easier to propagate than O.3 under North Eastern Central Canada climate. O.3A, a mutation of O.3 (Ottawa 3) was also added to the advanced lines and evaluated along with seven rootstocks in replicated trials compared to M.26, M.9, M.111 and O.3 in four locations during 1995–2002. These seven rootstocks (SJM15, SJM44, SJM127, SJM150, SJM167, SJM188, SJM189, along with O.3A are being released for commercial evaluation.

Cold winter temperatures is a limiting factor in many apple-growing regions, especially in Northern Central Canada where winter temperatures drop below –30°C (Asnong, 1982; Granger, 1981; Khanizadeh et al., 2003). In 1980–81 and 1986–87 (Granger, 1981) there were severe low temperature injuries to apple trees and it repeated again during 1993–94 (Khanizadeh et al., 2003).

Development and the use of hardy rootstocks had a significant effect on the apple production in Quebec and many growers are using winter-hardy rootstocks specially O.3, which was developed and released in early 1970 from AAFC in Ottawa (Heeney, 1976; Spangelo et al., 1974).

In 1960, a breeding program was established in Morden, Manitoba, to develop winter hardy rootstocks for cold climates. Several crosses were made during 1960–70 and the seedling was transferred to Fruit Breeding and Physiology Laboratory in AAFC–HRDC, at St-Jean-sur-Richelieu, Quebec, after closure of the breeding program in Morden. These rootstocks (SJM series) along with those (SJP84 series) developed at AAFC (Khanizadeh et al., 2003), were tested in several locations and survived the test Winters 1980–81, 1986–87, and 1993–94 (Granger, 1981; Khanizadeh et al., 2000). The objective of the program was to evaluate these seedlings under north-central eastern Canada climatic conditions and to determine their level of low temperature susceptibility and agronomic characteristics in an attempt to replace some of the less-hardy, disease-susceptible, or difficult-to-propagate rootstocks.

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Materials and Methods

A nursery was established in 1970 at Frelighsburg, Quebec (long. 72.83 W; lat. 45.05 N) to evaluate the agronomic characteristics of ‘McIntosh’ on 209 seedling rootstocks. Budded trees were kept in nursery for 2 years and then planted in Spring 1974. Trees (one per rootstock) were trained to a central leader system and spaced 1.2 × 4.6 m. Tree height, spread, vigor, circumference, yield efficiency, average fruit weight were recorded, as well as ratings of development of burr knots, number of sucker, disease susceptibility, and compatibility from 1974–2000. From the 209 seedlings, 19 were selected for further evaluation (Granger et al., 1991) due to their excellent resistant to low temperature (survival at several location after the test Winters 1980–81, 1986–87 and 1993–94), disease resistance and yield efficiency.

A stool bed was also established in 1991 to examine rooting efficiency, the number of commercial suckers and also resistance to woolly apple aphids (data not shown). After further testing in the stool beds and tree performance in Frelighsburg during 1991–97, seven selections that developed by crossing Nertchinsk with M.9 and M.26 (Table 1) were entered into the advanced St Jean-Morden (SJM) series and were planted in replicated trials. In 1997 two sites were selected under controlled conditions at grower fields, one in Dunham (long. 74.00 W; lat. 45.15 N) and the other in Mont St-Grégoire (long. 73.10 W; lat. 45.20 N). The seven advanced rootstocks (SJM127, SJM15, SJM150, SJM167, SJM188, SJM189 and SJM44) were planted along with M.26, M.9, MM.111, and O.3 as control. During the multiplication and evaluation of the rootstocks, a clone of O.3 (O.3A) was found to be different from O.3 developed earlier by

Spangelo et al. (1974). O.3A produced wider branch angles and had better rooting efficiency in the stool bed compared to O.3. O.3A was also tested along with the advanced SJM series rootstock in four sites.

A completely randomized design was used in two sites and three trees per rootstocks were randomized in each of the three replications. ‘McIntosh Summerland’ was used as scion to compare the relative size, circumference, tree cross section area (TCSA), height, spread, yield efficiency, total yield, fruit number, average fruit weight, and rating of burr knots and Suckers of SJM series and O.3A compare to M.26, M.9, M.26, MM.111, and O.3 in Mont St-Grégoire and Dunham. The trees were planted 5.5 × 3.0 m apart and were trained as central leaders and recommended normal orchard management practices were followed (Conseils des productions végétales du Québec, 1976). The relative size of the rootstocks was estimated compare to M.9 (rootstocks circ × 100/M9 circ) before data analysis. Average fruit weight (g) was calculated using 25 randomly selected fruit in each year. Circumference and TCSA were measured at 25 cm above graft union, burr knot incidence was rated using a scale of 0 (no burr knots) to 10 (completely covered the rootstocks), and number of suckers were counted annually. SJM44 and SJM127 were evaluated only at one orchard (Table 2) due to the insufficient number of rootstocks. No irrigation and thinning were done in either commercial site during the evaluation.

General linear model (GLM) procedure of SAS (1989) was used to analyze the data and least significant difference was used for mean comparison.

Results and Discussion

Data and information presented are from two replicated sites established in two orchards with some information that we collected from trees established at two research centers, L’Acadie (long. 73.35 W; lat. 45.32 N) and Frelighsburg to evaluate the performance in stool bed. All the reported SJM passed several test winters in Quebec including the harsh Winters 1980–81 (Granger, 1981), 1986–87, and 1993–94 (Khanizadeh et al., 2000). The relative size (vigor) of the SJM series rootstocks was estimated using circumference compared to M.9 using 2002 data. Data are presented for each site separately since there was a location × rootstock interaction for TCSA, yield efficiency, and total yield, indicating the response of rootstocks are site dependent. M.9 was the least vigorous rootstock in both commercial sites. SJM series rootstocks were relatively less vigorous than M.26 and O.3 in both sites, but this difference was nonsignificant. No

Table 1. Parentages of 7 SJM rootstocks series and the origin of O.3A.

Selection	Parentage
SJM15	Nertchinsk × M.9
SJM44	Nertchinsk × M.9
SJM127	Nertchinsk × M.26
SJM150	Nertchinsk × M.26
SJM167	Nertchinsk × M.26
SJM188	Nertchinsk × M.26
SJM189	Nertchinsk × M.26
O.3A	Mutation

Table 2. Performance of 7 SJM series and O.3A rootstocks using 'McIntosh Summerland' as scion compared to M.26, M.9, M.26, MM.111, and O.3 planted in 1997 in Mont St-Grégoire, Verger Yvan Duchesne (average of three trees per replication).

Rootstock	2002					Yield (kg)				Cumulative yield 1999–2002	Efficiency [cumulative yield/TCSA ^y (kg·cm ⁻²)]	Total no. of fruit ^x 1999–2002	Avg fruit wt (g) 1999–2002	Burr knots ^w 2002	Suckers ^v
	Relative size ^z	Circumference ^y (mm)	TCSA ^y (cm ²)	Ht (m)	Spread (m)										
	1999	2000	2001	2002											
SJM15	120	146	17	2.7	2.6	2.0	7.4	16.5	28.0	53.8	3.1	398	116	3.1	3.3
SJM44	135	164	21	2.9	2.9	0.3	5.4	20.3	31.3	57.3	2.8	412	134	0.8	0.0
SJM127	137	166	22	3.1	2.9	0.0	3.7	12.0	27.3	42.9	2.0	267	164	4.5	0.0
SJM150	134	163	21	3.2	2.8	1.8	7.7	21.0	38.4	68.9	3.2	511	120	3.3	0.7
SJM167	145	176	25	3.1	2.8	1.3	6.9	20.2	33.4	61.8	2.6	460	124	1.2	1.0
SJM188	129	157	20	3.1	2.8	0.0	6.1	12.8	21.7	40.4	2.1	318	106	3.8	1.5
SJM189	127	154	19	2.9	2.8	0.8	5.4	15.0	25.1	46.1	2.4	335	122	3.5	0.5
O.3A	116	141	16	2.8	2.8	1.0	8.7	18.8	30.9	59.1	3.8	420	125	1.3	1.7
M.26	151	183	27	3.3	3.2	0.6	3.9	12.1	32.1	48.6	1.9	293	163	3.0	0.0
M.9	100	121	12	2.4	2.6	0.6	6.7	10.5	25.5	43.2	3.8	306	133	2.9	2.7
MM.111	230	280	62	4.1	2.9	0.0	1.0	3.9	20.0	24.7	0.4	179	133	1.0	0.3
O.3	132	160	21	2.7	3.1	0.1	5.1	17.5	32.1	54.8	2.8	398	128	0.3	2.7
LSD ^v	28	34	10	0.6	0.7	1.9	4.1	9.4	12.0	21.9	0.8	149	25	1.8	3.6

^zRelative size = (rootstocks circ × 100/M9 circ).

^yCircumference and TCSA 25 cm above graft union.

^xTotal fruit number: fallen fruit + sampled and harvested.

^wBurr rating: 0 (no burr-knot s) to 10 (completely covered the rootstocks) and average number of suckers counted annually.

^vMean separation within columns by least significant differences ($p \leq 0.05$).

Table 3. Performance of 7 SJM series and O.3A rootstocks using 'McIntosh Summerland' as scion compared to M.26, M.9, M.26, MM.111 and O.3 planted in 1997 in Dunham, Verger Dupuis Inc (average of three trees per replication).

Rootstock	2002					Yield (kg)				Cumulative yield 1999–2002	Efficiency [cumulative yield/TCSA (kg·cm ⁻²)]	Total no. of fruit ^a 1999–2002	Avg fruit wt (g) 1999–2002	Burr knots ^w 2002
	Relative	Circumference ^c	TCSA ^a	Ht	Spread									
	size ^z	(mm)	(cm ²)	(m)	(m)	1999	2000	2001	2002					
2002														
SJM15	123	106	9	1.7	1.7	2.3	3.8	4.8	5.0	15.8	1.8	154	96	2.7
SJM44	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SJM127	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SJM150	156	135	15	1.8	2.2	1.7	6.1	4.1	11.5	23.4	1.6	199	115	3.9
SJM167	164	142	16	1.7	2.6	2.6	5.5	6.8	11.0	25.9	1.6	186	116	3.5
SJM188	137	118	11	1.8	2.1	2.0	3.5	4.7	2.7	12.8	1.1	108	106	5.0
SJM189	140	121	12	1.7	2.1	1.6	4.0	7.1	3.3	16.1	1.4	134	108	4.7
O.3A	160	139	15	1.9	2.2	3.2	8.3	6.7	13.1	31.2	2.0	270	103	0.7
M.26	173	149	18	1.8	2.7	1.6	5.7	2.4	12.7	22.2	1.3	185	119	3.3
M.9	100	86	6	1.8	1.6	0.9	2.6	1.7	5.3	10.3	1.8	94	116	3.0
MM.111	224	194	30	3.2	2.1	0.0	3.2	3.4	9.0	15.7	0.6	119	130	2.2
O.3	156	135	15	1.9	2.7	1.9	7.5	8.1	11.8	29.2	2.1	242	104	1.7
LSD	34	29	7	0.4	0.6	1.6	3.1	4.9	5.5	9.9	0.9	82	21	1.3

^zRelative size = (rootstocks circ × 100/M9 circ).

^yCircumference and TCSA 25 cm above graft union.

^xTotal fruit number: fallen fruit + sampled and harvested. Burr rating: 0 (no burr knots) to 10 (completely covered the rootstocks).

^wAverage number of suckers counted annually.

^vMean separation within columns by least significant differences ($p \leq 0.05$).

significant differences in vigour were observed between O.3A and O.3 in both sites (Tables 2 and 3). O.3A, SJM15, SJM150 and SJM167 were more precocious than other rootstocks. Total cumulative yield was lower in Dunham (Table 3) compared to Mont-St-Grégoire (Table 2). O.3A, SJM15, SJM150 and M.9 had the highest efficiencies in Mont St-Grégoire but highest efficiency observed for O.3A in Dunham (Table 3). O.3A produced the largest fruit weight followed by O.3, SJM150 and SJM15 in Dunham (Table 3) but less difference was observed between rootstocks in Mont St-Grégoire (Table 2). The rootstocks susceptibility to burr-knot was very different in each site and also in our experimental farms. O.3A had the least incidence of burr-knot in Dunham (Table 3). No significant differences were observed for of burr-knot between rootstocks in Mont St-Grégoire but higher level of burr-knot was observed on SJM150, SJM188 and SJM189 compared to the rest in Dunham. Cumulative number of suckers was also compared and no significant differences were observed between the tested rootstocks.

SJM15, SJM167, and O.3A stand out compared to standard based on the observation in two research centers and information collected in two replicated sites. The 7 SJM series along with O.3A is being released due to several excellent agronomic characteristics and performance and are available for testing using different cultivars (scion) and/or in different soil and climate condition. O.3A seems to be better adapted to sandy soil and showed higher efficiency and no symptoms of burr-knots compared to standard O.3. Average number of suckers was counted only at Mont St. Grégoire and no significant difference was observed between the rootstocks (Table 2).

A limited number of rootstocks should be available in 2005-2006 from AAFC National High Value Crop Breeding program.

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