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'SJM167' and 'SJM188', two new Winter Hardy Apple Rootstocks

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Summary

In 1960, a breeding program was initiated in Morden, Manitoba to develop winter hardy rootstocks for cold climates and then the program was transferred to Agriculture and Agri-Food Canada, Horticultural Research and Development Centre, at St-Jean-sur-Richelieu, Quebec. 'SJM167' (St-Jean Morden 167) and 'SJM188' (St-Jean Morden 188) were selected from the initial population and evaluated since 1970 in replicated trials. These two rootstocks were found to be very winter hardy, disease resistant, dwarfing, with good yield efficiency and were released for commercial evaluation and presently available from Canadian Food Inspection Agency in BC or from Meiosis Inc. in Europe (http://www.meiosis.co.uk).

Key words. Malus x domestica – fruit breeding – winter hardiness – dwarf-size controlling – efficiency

Introduction

Origin

'SJM167' (St-Jean Morden 167) and 'SJM188' (St-Jean Morden 188) are two new dwarfing rootstocks resulting from a cross made in 1960 between *Malus baccata* 'Nertchinsk' and 'Malling 26' ('Malling 16' x 'Malling 9'). It was developed at the Agriculture and Agri-Food Canada Horticulture Research and Development Center, St-Jean-sur-Richelieu, Quebec. 'SJM167' produces trees similar to 'M.26' and 'O.3' (Table 1) with similar efficiency (Table 2), while 'SJM188' produces trees similar to 'M.26' and 'M.9' (Table 1) with similar efficiency in Dunham but significantly lower efficiency compared to 'M.9' in Mont-St-Grégoire (Table 2). Both were released because of their winter hardiness, ease of propagation, pest and disease resistance and better tolerance to Quebec winters compared to 'M.9' and 'M.26' (Khanizadeh et al. 2000). 'SJM167' and 'SJM188' were among the 56 hybrid seedlings of 'Nertchinsk' x 'Malling 26' to which 'McIntosh VC309' was budded in 1971 and planted in 1974 at Frelighsburg, Quebec, where it was evaluated until 1984 for hardiness, tree size, and efficiency (Granger et al. 1991) along with other semi advanced 'SJP84' and SJM series (Khanizadeh et al. 2005). 'SJM167' and 'SJM188' were planted in 1997 in replicated trials in several plots at the Frelighsburg and L'Acadie, Quebec substations, and also at two grower sites, Mont-St-Grégoire and Dunham, Quebec. (Khanizadeh et al. 2005)

Materials and Observations

All observations were made on 10 plant parts. For flowers, they were taken at the start of anther dehiscence on an average of 10 second or third flowers with intact pedicels; for the current season's shoot, they were taken from the outside of the tree in summer while the tree is still in active growth; for the leaves, they were made on mature leaves taken in summer from the middle third of a vigorous shoot of the current season on the outside of the tree; for vegetative characteristics on rootstock varieties, they were made on plants cut back annually in the stool bed. 10 typical fruits were selected out of a minimum of 20 fruits from two trees and examined at peak maturity.

Description of self-rooted trees

Own-rooted trees of 'SJM167' and 'SJM188' are very prolific and began flowering in L'Acadie, Quebec, on April 30 and May 11 respectively compared to 'M.26' and 'O.3' which began flowering on May 8th and 1st. The colour of the 'SJM167' and 'SJM188' buds in full balloon stage is faded medium pink and white with pink along the margin fading towards the centre, respectively [RHS 58A (Royal Horticultural Society, 1995)], pedicels are green, and flowers are single with an average 4.3–4.4 cm diameter. Petals are ovate, broad ovate to almost oblong, overlapped, usually entirely white with occasional faded medium pink (RHS 58A) blush on the upper side and blushed (RHS54A) on the lower side.

The mature leaves of 'SJM167' are large with length between 8.5 and 9.7 cm, width between 5.2 and 6.0 cm, and a length to width ratio of 1.6. The leaves are medium green (RHS 137A), weak to medium glossy on the upper side, and sparse to moderate pubescent on the lower side with a downwards orientation. Petioles are between 1.4 and 1.7 cm long, and the shape of the leaf apex is acuminate or cuspidate with serrated margins, while 'SJM188' leaves are medium with length between 7.8 and 9.1 cm, width between 5.1 and 5.8 cm, and a length to width ratio of 1.5. The leaves are medium green, weak glossy on the upper side and moderate pubescent on the lower side, with an upwards to outwards orientation. Petioles are be-

Table 1. Burr knots, sucker number, circumference, trunk cross-sectional area (TCSA), height, spread, and vigour of 'McIntosh Summerland' at Dunham and Mont-St-Grégoire, Quebec, on 'SJM167' in comparison with 'M.26', 'O.3' and 'M.9' (1997 planting).

Genotype	Burr knots[1] (0–5)	Suckers (#) 2003	Circ.[2] (mm)	TCSA[3] (cm^2)	Height (cm)	Spread (cm)	Vigour relative 2004[4]
	Dunham						
'SJM167'	1.0	0.0	194	30	252	356	114
'M.26'	1.5	1.5	191	30	236	343	112
'O.3'	1.5	2.0	170	23	185	277	100
$LSD_{0.05}$	2.8	7.5	105	34	144	159	96
	Mont St-Grégoire						
'SJM167'	0.5	0.0	211	35.0	315	307	111
'M.26'	1.7	0.0	226	40.8	367	357	119
'O.3'	0.2	0.7	190	29.2	290	329	100
$LSD_{0.05}$	1.5	5.8	20	9.3	59	74	13
	Dunham						
'SJM188'	5.0	2.0	138	15	234	260	126
'M.26'	1.5	1.5	191	30	236	343	175
'M.9'	0.8	0.0	110	10	183	209	100
$LSD_{0.05}$	1.5	6.5	71	22	154	120	65
	Mont St-Grégoire						
'SJM188'	4.3	2.5	173	24.2	315	280	115
'M.26'	1.7	0.0	226	40.8	367	357	150
'M.9'	2.0	2.3	151	18.2	267	283	100
$LSD_{0.05}$	1.4	6.8	35	12	62	82	23

[1]Burr knots on a scale of 0-5. 0 = no burr knots; 5 = aerial section of rootstock is covered with burr knots.
[2]Circumference (mm): 25 cm above the graft union.
[3]TCSA cm^2: [(radius mm*radius mm) *3.1416]/100.
[4]Relative vigour to 'M.9': (circ. 'SJM188'/circ. of 'M.9')*100.
LSD = least significant difference.

tween 1.7 and 2.2 cm long and the shape of the leaf apex is cuspidate with serrated margins.

For 'SJM167' and 'SJM188' respectively, the reddish brown dormant 1-year-old shoot is 6.9 and 5.6 mm thick, and the length of internodes (at middle third of the shoot) is 22 and 16.6 mm based on averages of at least four replicates during the evaluation period. For 'SJM167', shoots have weak flexibility and numerous small to medium lenticels while for 'SJM188' they have weak to moderate flexibility and moderate to many mid-size lenticels.

Fruits of 'SJM167' are very small (10 g), flat to flat-globose, symmetrical and the ribbing is weak to very weak. Fruit crowning is weak and sometimes absent, the eye is small, closed to half closed, the calyx is persistent with short to medium lobes touching at the base and the eye ba-



Fig. 1. 'SJM167' (left) and 'SJM188' fruits (right)

Table 2. Precocity, cumulative yield (1999–2004), yield efficiency, and average fruit size of 'McIntosh Summerland' apple trees at Dunham and Mont-St-Grégoire, Quebec, on 'SJM167' in comparison with 'M.26', 'O.3' and 'M.9' (1997 planting).

Genotype	Yield (kg)[1]							Yield	Fruit size
	1999	2000	2001	2002	2003	2004	1999–2004	efficiency [2]	(g) 2004[3]
	Dunham								
'SJM167'	2.6	5.5	6.8	11.0	23.1	35.6	84.6	2.8	149
'M.26'	1.6	5.7	2.4	12.6	15.8	26.5	64.6	2.2	115
'O.3'	1.9	7.5	8.1	11.8	14.7	24.6	68.6	3.1	122
$LSD_{0.05}$	3.3	3.0	4.5	11.5	20.2	15.2	50.0	2.5	31
	Mont St-Grégoire								
'SJM167'	1.3	6.9	20.3	33.4	29.0	41.9	132.7	3.8	131
'M.26'	0.6	3.8	12.1	32.1	44.8	44.7	138.1	3.3	146
'O.3'	0.1	5.1	17.5	32.1	30.5	36.1	121.4	4.5	142
$LSD_{0.05}$	1.4	4.3	11.9	13.5	46.9	22.0	53.4	1.4	30
	Dunham								
'SJM188'	2.0	3.5	4.7	2.7	11.9	9.0	33.6	2.1	112
'M.26'	1.6	5.7	2.4	12.6	15.8	26.5	64.6	2.2	115
'M.9'	0.8	2.5	1.7	5.3	1.9	8.9	21.1	2.3	93
$LSD_{0.05}$	2.7	3.1	4.9	8.2	15.4	10.2	39.2	1.8	22
	Mont St-Grégoire								
'SJM188'	0.0	6.1	12.8	21.6	20.3	30.5	91.2	3.9	134
'M.26'	0.6	3.8	12.1	32.1	44.8	44.7	138.1	3.3	146
'M.9'	0.5	6.7	10.5	25.5	21.0	39.4	103.7	5.8	135
$LSD_{0.05}$	1.3	4.1	11.5	13.9	46.9	22.4	55.2	1.5	30

[1]Yield (kg) = includes weight of fallen, harvested, and sampled apples.
[2]Yield efficiency (kg cm^2) = (cumulative yield 1999 to 2004/ trunk cross-sectional area 2004).
[3]Size (g): average fruit size obtained from a randomly selected sample of 25 fruits
LSD = least significant difference.

sin is mainly outwards with a very shallow depth. The stalk is thin, long (1.3 to 2.8 cm) and the stem cavity is medium (9–13 mm). The skin is smooth with a heavy bloom and almost entirely (70–95 %) covered with a faded and solid over red (RHS 46B) over a medium pale yellow (RHS 4C) ground colour with low to medium russet around the stalk cavity. The lenticels are medium, and intermediate prominent, and the fruit flesh is yellowish (Fig. 1).

Fruits of 'SJM188' are slightly larger (15 g), flat to globose, mainly symmetrical, and the ribbing is strong (Fig. 1). Fruit crowning is weak to moderate, the eye is medium, mainly closed, the calyx is persistent with long lobes overlapping at the base, the eye basin is narrow and the stalk cavity is shallow. The stalk is thin (0.9 to 1.2 mm), long (2.2 to 3.8 cm) and the stem cavity is medium (9.9 to14.7 mm). The skin is smooth with a moderate bloom when present and highly (60–80 %) covered with a streaked, washed out and solid pinkish-red (RHS 55) over a yellow (RHS 4C) ground colour with absent or very low russet around the eye basin. The lenticels are small and not prominent to very slightly prominent, and the fruit flesh is yellowish.

Propagation (stool bed)

'SJM167' and 'SJM188' produces four to five shoots per plant compared to 'M.26', 'O.3' and 'M.9' which produces two to three. Average shoot diameter and lengths of 'SJM167' and 'SJM188' are 6.9 mm and 64 cm, and 5.6 mm and 56 cm, respectively. Both produce an average of 6 or 4 thorns or secondary branches per shoot.

Results

Performance in the Orchard

The performance of 'SJM167' and 'SJM188', using 'McIntosh Summerland' as a scion, has been monitored since 1997 in two commercial orchards located in Mont-St-Grégoire and Dunham, Quebec. It produces trees similar to 'M.26' and, 'O.3'. The trees grafted on 'SJM167' have similar yield efficiency (Table 2) and produce similar burr knots and suckers compared with 'M.26' and 'O.3' (Table 1). The trees grafted on 'SJM188' have similar

Table 3. Length of necrosis on excised apple rootstocks inoculated with four isolates of *Phytophthora cactorum*[x] and two races of *Erwinia amylovora*[y].

Rootstocks	Races of *Phytophthora cactorum* [x]				Races of *Erwinia amylovora* [y]	
	PC04-01	PC04-02	PC04-03	PC04-04	ST998	ST1585
'SJM167'	24.86	27.21	26.09	20.99	82.97	98.07
'SJM188'	42.35	46.49	44.69	35.94	61.15	60.05
'M.26'	34.67	41.48	36.28	29.18	63.17	66.40
'M.9'	17.17	20.21	17.04	13.70	81.70	94.82
'O.3'	23.40	26.25	25.54	20.54	100.00	90.92
$LSD_{0.05}$[z]	2.28	5.61	5.56	4.29	29.31	20.74

[x]Length (mm) of necrosis induced by *Phytophthora cactorum* isolates; data collected from Carisse and Khanizadeh (2006).
[y]Percentage of the shoot length with necrotic lesions after inoculation (Norelli et al. 2002).
[z]LSD : least significant difference at the 0.05 level of confidence.

yield efficiency in Dunham compared with 'M.26' and 'M.9' but significantly less in Mont-St-Grégoire compared to 'M.9' (Table 2). It produces significantly more burr knots than 'M.26' and 'M.9' but similar suckers (Table 1).

Diseases and pests

'SJM167' and 'SJM188' are resistant to scab and to woolly apple aphid, *Eriosoma lanigerum* (Hausman), based on visual observation since 1974, in stool bed. 'SJM167' is significantly less susceptible to the four races of *Phytophthora cactorum* (Leb. & Cohn) Schroet (Carisse and Khanizadeh 2006) compared to 'M.26' but is similar to 'O.3'. No difference was observed for susceptibility to one race of *Erwinia amylovora* (Burrill) compared to 'M.26' and 'O.3' (Table 3) but for ST1585, 'M.26' was significantly more resistant than 'SJM167' and 'O.3'. 'SJM188' is significantly more susceptible to the four races of *Phytophthora cactorum* compared to 'M.26' and 'M.9'. No difference was observed for susceptibility to one race of *Erwinia amylovora* compared to 'M.26' and 'M.9' (Table 3) but for ST1585, 'M.9' was significantly more susceptible than 'SJM188' and 'M.26'.

Availability

A Canadian Plant Breeder's Right (PBR) has been issued (PBR certificate number 2909 for 'SJM167' and 2996 for 'SJM188') and limited quantities of indexed bud-woods are available for research purposes (universities and research centers) from Canadian Food Inspection Agency, Shahrokh Khanizadeh (for North America) or Meiosis (http://www.meiosis.co.uk) for Europe following a written request. Interested nurseries may inquire about "non-exclusive licenses" directly from Agriculture and Agri-Food Canada, office of technology transfer.

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