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Performance of 'Cortland' and 'McIntosh' on Fourteen Rootstocks in Quebec

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Abstract

'Cortland', 'Imperial McIntosh' and 'Macspur McIntosh' were evaluated over a 10-year period on the following rootstocks: M.26 EMLA, M.4 EMLA, M.7 EMLA, 'McIntosh' seedling, MM.106, MM.111, Ottawa hybrid (OH)-3, Ottawa (Ott.) 3, Ott.5, Ott.7, Ott.8, Ott.11, Ott.12 and *Malus robusta* 5. Scion cultivars on M.26 EMLA and Ott.3 were smaller than scion cultivars on all other rootstocks and tended to be more yield efficient than those on most other rootstocks. Root suckers were most prevalent on M.7 EMLA and Ott.8 rootstocks. Fruit size was largest on M.26 EMLA and generally smaller in 'McIntosh' than in 'Cortland.'

Introduction

Apple growing in Quebec is confined primarily to the southern portion of the province adjacent to New York and Vermont. Spring frosts and cold winters can cause significant tree damage (4); therefore, cold-hardy rootstocks that do not promote early bud break are required in Quebec. MM.106, MM.111, and M.26 EMLA are reliable rootstocks but have shown a lack of hardiness in some grower orchards. A series of hardy rootstocks, some with dwarfing characteristics, was developed in Ottawa (6, 9, 10). These rootstocks appeared to be of promise for orchards in Quebec, where they have been extensively tested in an experiment initiated in 1971 at the Agriculture Canada Research Station orchard in Frelighsburg. This paper presents the results obtained with 3 scion cultivars and 14 rootstocks over a 10-year period.

Materials and Methods

Rootstocks in the trial included M.26 EMLA, M.4 EMLA, M.7 EMLA,

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MM.106, MM.111, Ottawa (Ott.)3, Ott.5, Ott.7, Ott.8, Ott.11, Ott.12, Ottawa hybrid (OH)-3, *Malus robusta* R-5, and a 'McIntosh' seedling. The EMLA and MM rootstocks were obtained from a commercial source, the Ottawa series from a stool-bed at Frelighsburg, and 'McIntosh' seedling from seed. All rootstocks were planted in 1971 and budded to 'Cortland', 'Imperial McIntosh' or 'Macspur McIntosh' in 1973. Trees were planted at 2.7 x 5.1m (9x17 feet) in a split plot consisting of a randomized complete block design with 3 blocks. The scion cultivars were randomized in the main plots within each block and rootstocks were randomized within each scion cultivar. Each scion cultivar-rootstock combination was replicated 6 times in each block. Standard horticultural practices were applied to all trees. Alleyways were sod and tree rows were treated with herbicides to maintain them nearly weed free. Trees were cropped beginning in 1974.

Fruit number, fruit weight, trunk circumference, tree height, and tree spread were recorded annually for each tree. Root sucker count and removal began in 1979. Fruits in 1984 were sized into the following categories: 57mm (2 1/4"), 63mm (2 1/2"), 70mm (2 3/4"), 76mm (3"), 82mm (3 1/4") and 89mm (3 1/2").

Data were analyzed by GLM (General linear models) of SAS Statistical Analysis System, Carey, NC). All proportional data were transformed by arcsine square root percentage prior to analysis of variance. Means separation was by Duncan's multiple range test.

Results

There was an interaction between rootstocks and scion cultivars, i.e. the scion cultivar effects and the rootstock effects were not independant, therefore, the analysis of variance was performed on individual scion cultivars.

'Cortland' (Table 1). Trunk cross-sectional area (TCSA) was smaller for the M.26 EMLA, Ott.3, and Ott.8 trees than for the trees of all other rootstocks, and greater for the Ott.11, OH-3, and R-5 trees than for the 'McIntosh' seedling, Ott.7, Ott.12, Ott.5, M.4 EMLA, MM.106, M.7 EMLA, MM.111, Ott.8 and M.26 EMLA trees. Cumulative

Table 1. Performance of 'Cortland' on 14 rootstocks (n = 3).

Rootstock	TCSA[1] (cm^2)	Yield[2] (kg)	Efficiency (kg/cm^2)	Height (m)	Spread (m)	Number of rootsuckers
M.26 EMLA	38 g[3]	97 g	2.6 cd	2.09 h	2.87 h	4.9 cd
M.4 EMLA	85 ef	242 abc	2.8 bcd	3.53 f	3.89 def	3.3 cd
M.7 EMLA	73 f	184 def	2.5 d	3.62 ef	3.83 ef	24.7 a
'McIntosh' sdlg	122 bc	202 cde	1.7 ef	4.41 bc	4.29 abcde	1.9 cd
MM.106	75 f	214 bcd	2.9 bcd	3.88 def	3.94 cdef	2.4 cd
MM.111	80 f	160 ef	2.0 e	3.68 ef	3.97 cdef	4.2 cd
OH-3	145 a	205 cde	1.4 fg	5.07 a	4.54 ab	3.5 cd
Ott.3	39g	145 f	3.7 a	2.08 h	2.81 h	4.6 cd
Ott.5	91 ef	273 a	3.0 bc	4.14 cde	3.70 fg	0.1 d
Ott.7	119 cd	145 f	1.2 g	4.82 ab	4.35 abcd	0.5 d
Ott.8	54 g	165 def	3.1 b	2.85 g	3.39 g	24.7 a
Ott.11	157 a	204 cde	1.3 fg	5.19 a	4.64 a	9.0 bc
Ott.12	101 de	263 ab	2.6 cd	4.34 bcd	4.11 bcde	1.1 d
R-5	138 ab	216 bcd	1.6 fg	5.13 a	4.39 abc	13.9 b

[1]Trunk cross-sectional area.
[2]Cumulative yield from 1975 to 1984.
[3]Means separation within columns by Duncan's multiple range test, P = 0.05.

Table 2. Performance of 'Imperial McIntosh' on 14 rootstocks (n = 3).

Rootstock	TCSA[1] (cm^2)	Yield[2] (kg)	Efficiency (kg/cm^2)	Height (m)	Spread (m)	Number of rootsuckers
M.26 EMLA	44 d[3]	93 f	2.1 ab	2.07 e	2.96 c	3.0 cde
M.4 EMLA	101 bc	194 abcd	1.9 bc	3.54 c	3.92 b	9.4 b
M.7 EMLA	84 c	169 bcde	2.4 a	3.59 bc	4.10 ab	25.8 a
'McIntosh' sdlg	120 bc	177 bcde	1.5 de	4.08 ab	4.21 ab	0.7 e
MM.106	92 bc	170 bcde	1.8 bc	3.67 bc	3.99 b	0.1 e
MM.111	101 bc	159 cde	1.6 cd	3.98 abc	4.36 ab	2.2 de
OH-3	168 a	222 ab	1.3 def	4.45 a	4.77 a	3.3 cde
Ott.3	24 d	50 g	2.1 ab	1.98 e	2.35 d	0.3 e
Ott.5	85 c	175 bcde	2.1 ab	3.74 bc	4.02 b	0.5 e
Ott.7	167 a	138 def	0.8 g	4.36 a	4.31 ab	0.7 e
Ott.8	89 c	169 bcde	1.9 bc	3.05 d	4.00 b	10.5 b
Ott.11	109 bc	117 ef	1.1 fg	3.78 bc	4.21 ab	6.4 bcd
Ott.12	112 bc	239 a	2.1 ab	3.95 abc	4.21 ab	1.0 e
R-5	154 a	180 abcd	1.2 efg	4.30 a	4.29 ab	7.3 bc

[1]Trunk cross-sectional area.
[2]Cumulative yield from 1975 to 1984.
[3]Means separation within columns by Duncan's multiple range test, P = 0.05.

yield per tree was higher for scion cultivars on Ott.5 and Ott. 12 than for those on OH-3, Ott.11, 'McIntosh' seedling, M.7 EMLA, Ott.8, Ott.7, Ott.3 and M.26 EMLA. It was lower for scion cultivars on M.26 EMLA than for those on all other rootstocks. Yield efficiency was highest for scion cultivars on Ott.3, and lower for the larger trees. Canopy size was smallest for scion cultivars on Ott.3 and M.26 EMLA followed by scion cultivars on Ott.8. Rootsuckers were most prevalent from M.7 EMLA and Ott.8.

Table 3. Performance of 'Macspur McIntosh' on 14 rootstocks (n = 3).

Rootstock	TCSA[1] (cm^2)	Yield[2] (kg)	Efficiency (kg/cm^2)	Height (m)	Spread (m)	Number of rootsuckers
M.26 EMLA	34 cd[3]	79 e	2.3 bcd	2.03 f	2.60 ef	7.1 bcd
M.4 EMLA	119 a	292 a	2.5 bc	3.53 bcd	4.45 a	9.1 bc
M.7 EMLA	82 b	188 cd	2.3 bcd	2.87 e	3.99 ab	24.5 a
'McIntosh' sdlg	136 a	267 ab	2.0 de	4.35 a	4.11 ab	1.3 cd
MM.106	65 bc	167 d	2.6 bc	3.29 de	3.72 bc	1.4 cd
MM.111	77 b	169 d	2.2 cd	3.53 bcd	3.83 abc	1.4 cd
OH-3	140 a	243 abc	1.8 ef	3.95 abc	4.23 ab	10.9 b
Ott.3	18 d	58 e	3.2 a	1.74 f	2.10 f	0.7 cd
Ott.5	60 bc	161 d	2.7 b	2.82 e	2.89 de	0.1 d
Ott.7	149 a	149 d	1.0 g	4.09 ab	3.91 abc	1.2 cd
Ott.8	72 b	162 d	2.2 cd	2.86 e	3.26 cd	22.4 a
Ott.11	132 a	188 cd	1.4 f	4.20 a	4.46 a	8.3 bcd
Ott.12	84 b	214 bcd	2.6 bc	3.49 cd	4.00 ab	0.9 cd
R-5	130 a	252 abc	2.0 de	4.30 a	4.31 ab	10.6 b

[1]Trunk cross-sectional area.
[2]Cumulative yield from 1975 to 1984.
[3]Means separation within columns by Duncan's multiple range test, P = 0.05.

Table 4. Fruit size in 'Cortland,' 'Imperial McIntosh' and 'Macspur McIntosh' on 14 rootstocks in 1984.

Rootstock	'Cortland'			'Imperial McIntosh'			'Macspur McIntosh'		
	% Sm[1]	% Med[1]	% Lge[1]	% Sm	% Med	% Lge	% Sm	% Med	% Lge
M.26 EMLA	5 f[2]	41 b	53 a	19 g	67 abc	14 a	16 e	61 bcd	22 a
M.4 EMLA	11 ef	53 a	35 bcde	39 bcd	58 cde	2 b	26 bc	61 bcd	3 b
M.7 EMLA	11 ef	48 a	40 b	30 def	67 abc	3 b	23 de	72 ab	5 b
'McIntosh' sdlg	16 abcde	52 a	32 bcde	31 def	67 abc	2 b	36 bc	62 bcd	2 b
MM.106	14 bcde	46 ab	40 bc	34 cdef	63 abc	3 b	34 bcd	63 abc	2 b
MM.111	12 def	51 a	36 bcde	37 cde	61 bcd	2 b	34 cd	64 abc	2 b
OH-3	20 abcd	51 a	29 cde	43 bc	54 de	2 b	45 bc	54 cd	1 b
Ott.3	24 a	40 b	37 bcd	39 bcd	58 cde	3 b	47 b	51 d	2 b
Ott.5	21 abc	53 a	26 e	58 a	39 f	3 b	59 a	36 e	5 b
Ott.7	13 cde	49 a	38 bc	27 efg	71 a	2 b	21 e	73 a	6 b
Ott.8	11 ef	52 a	36 bcde	26 fg	70 a	4 b	34 cd	58 cd	8 b
Ott.11	19 abcde	49 a	32 bcde	48 b	51 e	1 b	37 bc	61 bcd	2 b
Ott.12	16 abcde	52 a	32 bcde	29 def	68 ab	3 b	42 bc	55 cd	3 b
R-5	22 ab	51 a	27 de	39 bcd	58 cde	3 b	40 bc	58 cd	2 b

[1]Sm = small; Med = medium and Lge = Large. Respective sizes were < 63 mm, > 63 mm < 76 mm, and > 76 mm.
[2]Means separation within columns by Duncan's multiple range test, P = 0.05.

'Imperial McIntosh' (Table 2). TCSA was smallest for the M.26 EMLA and Ott.3 trees and largest for the Ott.7, OH-3 and R-5 trees than for the trees of all other rootstocks. Cumulative yield was higher for the Ott.12 trees than for most others except those of M.4 EMLA, OH-3 and R-5. It was lower for the M.26 EMLA and Ott.3 trees than for all other rootstocks. Yield efficiency was better for the M.7 EMLA trees than for most of those having M.26 EMLA, Ott.3, Ott.5, or Ott.12 rootstocks and worse for trees of Ott.7 than for trees of all but trees of Ott.11 or R-5. The shortest trees with the least spread were those of M.26 EMLA and Ott.3. Incidence of rootsuckers was highest for trees having the M.7 EMLA rootstock.

'Macspur McIntosh' (Table 3). TCSA was smallest for the Ott.3 trees and largest for the Ott.7, OH-3, 'McIntosh' seedling, Ott.11, R-5, and M.4 EMLA trees. Cumulative yields of the M.4 EMLA trees were higher than all others, except those having 'McIntosh' seedling,' OH-3 and R-5 rootstocks. The presence of rootsuckers was highest on the M.7 EMLA and Ott.8 trees.

Fruit size (Table 4). The proportion of large fruit was highest for the M.26 EMLA trees of the three scion cultivars. Small fruits were predominant for the Ott.5 trees for the two 'McIntosh' strains. Fruit size tended to be smaller for the 'McIntosh' strains than for 'Cortland'.

Discussion

A rootstock trial in Poland showed TCSA values for 'Cortland' in the order MM.111 > M.7 EMLA, MM.106 > M.26 EMLA (1). Cumulative yield was lowest for trees of M.26 EMLA, and yield efficiency was greater for trees of MM.106 than of M.26 EMLA. Results in the present study concur with the smaller TCSA and lower yield of trees of M.26 EMLA, but yield efficiency was comparable for trees of M.26 EMLA and those of MM.106 (Table 1). 'McIntosh', in the study by Czynczyk and Olszewska (1), had a smaller TCSA on the M.26 EMLA than on the M.7 EMLA, MM.106, or MM.111 trees. Yield was highest for trees of MM.106, lowest for trees of M.26 EMLA, and efficiency was greatest for trees of MM.106. Our results

showed a smaller TCSA for trees of M.26 EMLA than those of M.7 EMLA. However, TCSA for trees of M.7 EMLA was not significantly smaller than that of the MM.106 and MM.111 trees (Table 2). Although yield was lowest for trees on M.26 EMLA, yield efficiency on this rootstock was comparable to that of trees of the other rootstocks. Ferree and Schmid (3) found that smaller 'McIntosh' trees were produced when Ott.3 and M.26 EMLA were used as rootstocks than when Ott.5, Ott.8 or Ott.11 were used and the smaller trees tended to have higher yield efficiencies. These results concur with those of the present study (Table 2).

Several studies with 'McIntosh' on M.26 EMLA and M.7 EMLA showed no difference in TCSA (2), a larger TCSA for trees of M.7 EMLA (5,8), no difference in yield efficiency (2,8), a lower yield efficiency of the M.7 EMLA trees (5), and a slightly better efficiency of the M.7 EMLA trees (7). Results in the present study showed a smaller tree when the scion cultivar was on M.26 EMLA than on M.7 EMLA, but tree efficiency was similar for both rootstocks (Table 2).

'Macspur' performed better than 'Imperial McIntosh' and tended to have smaller TCSA values on MM.106, M.7 EMLA, or M.26 EMLA in the study by Mika and Piatkowski (8). The comparable trees in the current study showed the same trend for TCSA, but tree efficiency was better for 'Macspur' only on MM.106 (Tables 2 and 3).

In summary, good tree performance and small tree size can be expected with 'Cortland' and 'McIntosh' on M.26 EMLA or Ott.3. M.26 EMLA may be preferred because of larger fruit size.

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Resistance to *Botrytis cinerea* in Pistillate Strawberry Genotypes

In extreme cases grey mold *(Botrytis cinerea)* resulted in necrosis of flowers and pedicels before fruit development had begun. This occurred in a significantly higher proportion of hermaphrodite than pistillate flowers. Necrosis due to grey mold in unripened and ripe berries was also significantly greater in plants with hermaphrodite flowers. Differences in susceptibility between families were also observed, but there was no interaction with flower sex. It is proposed that the reduced incidence of necrosis on the flowers and fruit of pistillate plants is due primarily to the absence of anthers, which in hermaphrodite flowers provide a major route for *B. cinerea* to enter the developing receptacle. From Simpson. 1991. *J. Hort. Sci.* 66(6):719-723.