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Management of high-density orchards in Quebec

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Management of high-density orchards in Quebec

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Conduite des vergers à fortes densités au Québec

Résumé

L'arboriculture fruitière au Québec subit présentement des changements rapides et radicaux. Les pommeraies constituées d'arbres de taille conventionnelle se transforment en plantation à fortes densités ne comportant que des arbres nains ou semi-nains. Les rangs simples y prédominent. Les nouvelles formes les plus en vogue sont la "cloche étroite" et la "palmette oblique". Chez le pommier, les porte-greffes les plus utilisés sont la 'Mailing 9', le 'Malling 26', l''Ottawa 3' et 'Malling 7'. Les résultats des recherches initiées à la Station de Recherches de Saint-Jean tendent à démontrer que l''Ottawa 3' est supérieur. Dans la conjoncture économique actuelle, huit hectares de pommiers nains plantés à forte densité pourraient procurer à l'arboriculteur fruitier du Québec un revenu convenable.

Pour le poirier, on y utilise encore le franc de 'Bartlett' comme porte-greffe. Par ailleurs, les francs du prunier indigène, le 'Myrobolan' et le 'Brompton' sont les porte-greffes du prunier les plus employés. Les essais effectués avec d'autres porte-greffes de poirier et de prunier sont très limités. Les cultivars de griottiers et de cerisiers à fruits doux sont surtout greffés sur les francs de 'Mazzard', de 'Mahaleb' et du clone 'Mazzard F12'.

Une série de questions et réponses concernant les particularités de la pomiculture au Québec apparaît en annexe.

Contribution no J. 850 de la Station de Recherches, Direction de la Recherche, Agriculture Canada, Saint-Jean-sur-Richelieu, Québec.

Communication présentée le 20 août 1980, au Colloque International sur l'Horticulture patroné par les Floralies de Montréal, Québec.

Abstract

Québec's fruit growing industry is now experiencing rapid and important changes. Standard size fruit trees are being replaced by dwarf and semi-dwarf ones. Single row systems are prevailing at the moment. The most common training systems are the "slender bell" and the "oblique palmette". Concerning apples, the 'Malling 9', 'Malling 26', 'Ottawa 3' and 'Malling 7' rootstocks are in prominent use. Of these, 'Ottawa 3' showed a superior performance. Given present economic conditions, it seems that eight hectares of dwarf apple trees planted in a high density system can viably support one Québec grower.

'Bartlett' seedlings are still the most popular rootstock for pears in this province while native plum seedlings, and the clones 'Myrobolan' and 'Brompton' are the usual plum rootstocks. Trials with other plum and pear rootstocks have been very limited. Sour and sweet cherry cultivars are mainly grafted on 'Mazzard' and 'Mahaleb' seedlings or on 'Mazzard F12' clones.

A series of questions and answers regarding some unusual aspects of the regional fruit tree culture is included.

Contribution No J 850, Research Station, Research Branch, Agriculture Canada, Saint-Jean-sur-Richelieu, Québec.

Paper presented at a colloquium on horticulture held at the International Floralies, Montréal, Québec, August 20, 1980.

In recent decades, fruit growers in most pome - and stone-fruit producing countries have tended to cultivate fruit trees which are adapted to their own regions; small, early-bearing, heavy producers of quality fruit. It has been found that profits depend on optimum fruit tree density over a given area, together with good orchard management.

Québec's fruit growers too have begun to realize that dwarf and semi-dwarf fruit trees, properly managed, are their only hope of survival. Apple orchards, particularly those with 90 to 180 trees per hectare, are being replaced by new plantings with 600 to 3 500 trees per hectare. The same tendencies, although slightly less marked, are evident among pear, plum and cherry growers.

Training systems

The training systems in most common use in Québec at the present time are the "slender bell" and the "oblique palmette" methods (fig 1 and Pl. I, figs h and j). Trees trained to these forms are normally provided with some kind of support and are nearly always planted in single rows. Some trees are also left "free-growing", without any support.

Local tests tend to demonstrate that, in terms of apple production and profits, of the following four training systems, the "free-growing tree", "Van Roechoudt palmette", "oblique palmette", and "slender bell", the two most promising forms are the "slender bell" and the "oblique palmette"* (Pl. I, figs h, i, j and k). The "slender bell" is closely related to the "slender spindle" described in this report by Dr. S.J. Wertheim. This form is obtained either by leaving the central stem intact after the second foliation, or by cutting it back each year, depending on whether the French "vertical axis" or the Dutch "slender

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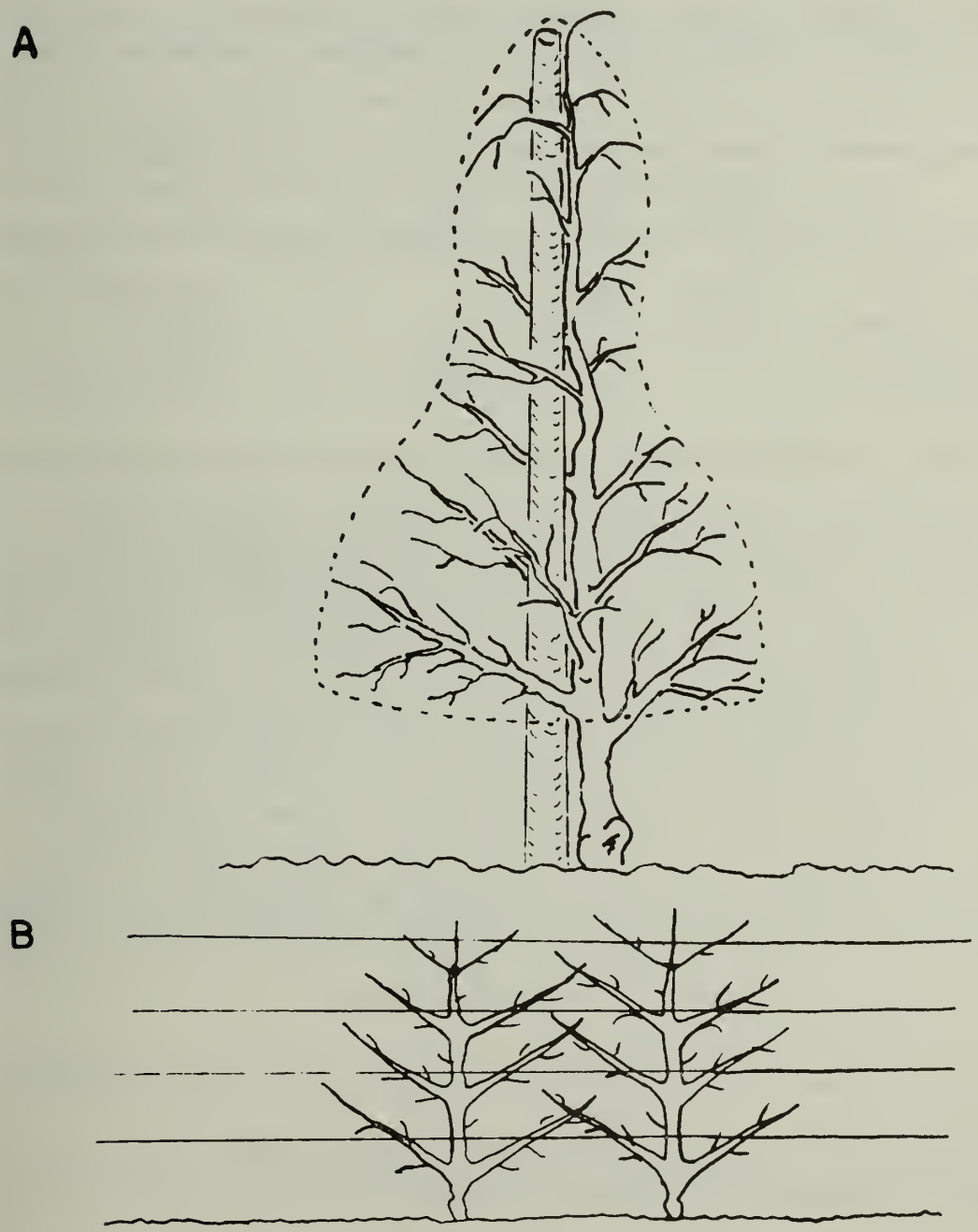
* All these training systems are described in Saint-Jean Research Station bulletin J-642.

Figure 1 Principal training systems used for apple trees in Québec:
A slender bell or *slender spindle*
B oblique palmette



spindle" system is being used. In the first case, the leading shoot must be attached to a good-sized stake or raised on wire support, otherwise the weight of the crop will soon cause it to bend and break (Pl. II, fig g). At the Frelighsburg experimental sub-station, the "slender bell" method has encouraged heavier and earlier fruit production than the other training systems (Table 1).

TABLE I Average production (kg/ha) by training system and density of 4th-year dwarf and semi-dwarf apple trees, Frelighsburg 1979

Training system	Density** in trees/ha			Average
	2960	1480	740	
Slender bell	9220 a	5344 a		7282 a
Oblique palmette	7320 b	3870 c		5595 b
Free-standing		5340 a	3521 a	4431 c
Van Roechoudt palmette		3943 b	1806 b	2875 d

Our current tests appear to indicate the need for a stake or point of attachment to support dwarf and sometimes even semi-dwarf trees, which, under our climatic conditions, have a strong tendency to bend when the soil softens during the spring thaw (Pl. II, fig f). The same phenomenon may also occur during the summer, as a result of wind, rain or the weight of a crop which is poorly distributed around the central axis. This is why, as shown in table 1, "free-standing" apple trees show reduced production as compared to "slender bell" and "oblique palmette" trees. Since apple trees trained by the "Van Roechoudt palmette" system must be severely pruned in their 2nd and 3rd seasons, it is difficult to compare them to other apple trees in terms of production.

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a Non-significant difference (at the 5% level) form data followed by the same letter.

** In this text, density will be described as high (2960 trees/ha), medium (1480 trees/ha) or low (740 trees/ha).

In Québec, since the weight of snow and ice tend to break the lower branches of dwarf or semi-dwarf trees, it is often important to attach the lateral branches of these fruit trees to a central support or wire (Pl. II, fig e).

The commonest training system for pear, plum and cherry trees is the "free-standing" or "bell" tree, normally without any form of support. The espaliered forms used in British Columbia for the 'Anjou' pear do not yet exist in Québec. Similarly, the system of training strong lateral branches on sour cherry trees for easier mechanized picking is not yet in use on Québec. While some fruit growers have trained their plum trees into the "goblet" shape, the most common and the most practical forms for the plum tree in Québec remain the "free-standing" tree and the "bell" free.

Rootstocks

Given present economic conditions, it is essential that fruit production costs be reduced. With regard to apples, Dr. Ronald Tukey (1971) notes that picking, pruning and pest control account for nearly 40 % of the total of these costs. Other economic studies performed in the state of New York (Snyder, 1968) have demonstrated that the use of dwarf and semi-dwarf apple trees helps to reduce production costs considerably. The same observation made in Québec (Garon and Ouellet, 1978) has led us to recommend the exclusive use of rootstocks which will produce trees of dwarf and semi-dwarf size and which are adapted to our climatic conditions. These include 'Malling 26', 'Ottawa 3', 'Malling 7' and 'Malling 9'; the last-named, however, should be used only to a limited extent.

'Malling 9'

'Malling 9' is a dwarfing rootstock which was tested at the Ottawa Research Station from 1938 to 1970. There it proved to be cold-sensitive

(Davis *et al.*, 1948). In Russia, too, it is considered non-hardy (Margolin, 1951 and Smirnov, 1960). In Quebec, 'Malling 9', cultivated on turfed land near Macdonald College, has survived our winters for at least 22 years (Taper, 1979). However, after their first season, poorly matured specimens of 'McIntosh' and 'Spartan' cultivars on 'Malling 9', growing on bare ground at the Frelighsburg sub-station, suffered considerably from the cold during the winter of 1975-76 (Rousselle *et al.*, 1976).

In our Frelighsburg experimental plots, young 'Malling 9' was the least productive of the dwarf-type rootstocks (Table 2).

TABLE 2 Average production (kg/ha) of 'McIntosh' and 'Spartan' cultivars per rootstock and planting density of 4th-year dwarf and semi-dwarf apple trees, Frelighsburg 1979

Rootstock	Density in trees/ha			Average
	2960	1480	740	
Ott 3	14229 a	8756 a	4150 a	8972 a
M 26	7617 b	3797 c	3576 b	4696 b
M 9	7403 c	4312 b	1568 d	4605 c
M 7	6810 d	3697 d	2104 c	4077 d

a Non-significant difference (at the 5% level) from data followed by the same letter

This rootstock appears to perform well with the cultivars best adapted to high-density planting, such as 'Empire'*, 'Golden Delicious'* and 'Red Haralson'** (Pl. I, e and f).

At Vineland, Ontario, 'McIntosh', 'Cortland' and 'Red Delicious' trees, all on 'Malling 9', have produced an average of two bushels per tree from the 5th to the 10th season. At the same location, 'McIntosh', 'Spy' and 'Red Delicious' apple trees on 'Malling 9', considered relatively old (between 20 and 25 years old), produced an average of

* cultivar sensitive to cold injury; should be grown in a selected area where winter damage does not usually occur

** gives poor quality fruits when grown under harsh winter conditions

54 kg (3 bushels) of apples per tree (Hutchinson, 1964). Some of these trees produced up to 72 kg (4 bushels). In Ottawa, the annual yield of 'McIntosh' trees on 'Malling 9' has been 16 to 27 kg per tree between the ages of 12 and 25 years. 'Malling 9' requires soil which is relatively heavy and well watered, but well aerated and drained (Granger *et al,* 1974).

Based on the results obtained on our Frelighsburg plots with 'Spartan' and 'McIntosh' cultivars on 'Malling 9', it appears that the optimum density for this rootstock is approximately 2960 trees per hectare with the "slender bell" system. With other training systems on 'Malling 9', that is, "free-standing", "oblique palmette" and "Van Roechoudt palmette" trees, they also produce their optimum yield per tree at high density. These densities are 2960 and 1480 trees per hectare for the "slender bell" and "oblique palmette" systems respectively, and 1480 and 740 trees per hectare for the "Van Roechoudt palmette" and "free-growing" systems.

In recent years, some of our apple growers have found that the new virus-free 'Malling 9' is too vigorous and not as productive as the older specimens which were subject to virus diseases. It has also been noted that, under our very humid climatic conditions, 'Malling 9' tends to form aerial root galls, known in English as burr knots; there galls interfere with normal sap circulation and leave the tree more vulnerable to cold and to certain diseases (Pl. II, fig d).

'Malling 26'

Created in 1929 at the East Malling Research Station in England by a cross between 'Malling 16' and 'Malling 9', 'Malling 26' was distributed for some time as number 3426. It is currently one of the most popular rootstocks sold in Canada. It has been tested at the Ottawa Research Station and is still being tested at the Saint-Jean Research Station in Québec, the Smithfield, Vineland, Harrow, Simcoe and Guelph Research Stations in Ontario and the Kentville Station in Nova Scotia (Granger

et al, 1974).

At Vineland, Ontario, 'Malling 26' has produced an average of two bushels from the 5th to the 10th season. At Frelighsburg, with 'Spartan' and 'McIntosh' cultivars, its early yield has been superior to that of 'Malling 9' and it has been ranked second (Table 2). It should be noted that 'Malling 26' is more compatible with the 'McIntosh' cultivar than is 'Malling 9' (Table 3).

TABLE 3 Average production (kg/ha) of 4th-year dwarf and semi-dwarf apple trees, Frelighsburg 1979

Rootstock	Cultivar	
	'Spartan'	'McIntosh'
Ott 3	8972 a	8691 a
M 9	6564 b	2552 d
M 26	5206 c	4186 c
M 7	3298 d	4855 b

a Non-significant difference (at the 5 % level) from data followed by the same letter.

When cultivated in suitable soil, that is, good, well-drained, gravelly soil with good water retention, 'Malling 26' produced heavier vegetative growth than 'Malling 9'. In our experimental plots, however, 'Malling 26' has produced heavier vegetative growth than 'Malling 9', thus necessitating more extensive pruning (Table 4).

TABLE 4 Average trunk diameter of 4th-year dwarf and semi-dwarf apple trees, Frelighsburg 1979

Rootstock	Density in trees/ha			Average
	2960	1480	740	
M 7	4.00 a	4.32 a	4.49 a	4.27 a
M 25	3.85 ab	3.84 b	4.44 a	4.04 ab
Ott 3	3.65 b	3.87 b	3.94 b	3.82 b
M 9	2.83 c	2.99 c	3.01 c	2.94 c

a Non-significant difference (at the 5% level) from data followed by the same letter

Of the dwarf-type rootstocks, 'M 26' has produced the highest proportion of large fruit, as reflected by average apple weight (Table 5).

TABL 5 Average weight (g/fruit) of fruit from 4th-year dwarf and semi-dwarf apple trees, Frelighsburg 1979

Rootstock	Density in trees/ha			Average
	2960	1480	740	
M 7	154 c	166 a	160 b	161 a
M 26	159 a	160 b	161 a	159 b
M 9	156 b	155 c	140 c	151 c
Ott 3	143 d	149 d	160 b	150 d*

a Non-significant difference (at the 5% level) from data followed by the same letter

In our climate, 'Malling 26' has proven much hardier than 'Malling 9' (Rousselle *et al.*, 1976). Introduced to our region ten years ago, this rootstock has not yet been affected by the cold. According to reports from the Ottawa Research Station, 'M 26' is more sensitive to cold than '*Malus robusta* 5' but in Minnesota these two rootstocks have been found

* a 150 g apple represents usually a commercially acceptable size

to be equally hardy (Watkins, 1968; Granger *et al*, 1974).

In Québec, 'Malling 26' has been shown to be sensitive to bacterial fire blight (*Erwinia amylovora* Burr. Winsl. *et al*), although, after grafting, this disease rarely affects the rootstock itself. The major problem observed with 'Malling 26' in Québec involves its strong tendency to develop aerial root galls or burr knots (Pl. II, fig d). To counter this tendency, the exposed portion of 'Malling 26' may be brushed with a 1 % solution of naphthaleneacetic acid (NAA). This solution may be mixed with a small quantity of white Latex-type paint. It is important to treat the galls as soon as they appear, or they will form large patches which will interfere with the circulation of the sap. It is also totally inadvisable to use poorly perforated mouse guards around the trunks, since they help to keep the crown and aerial base of the tree in an atmosphere of constant humidity, which promotes the formation of these galls. It is also important to eliminate tall grass or weeds near the apple trees, since these too maintain a high percentage of humidity at the foot of the trees. If it is necessary to use protectors against field voles, it is therefore wise to use those which are made of wire netting. Finally, it should be noted that Malling 26 performs very poorly in soil which is too light or too dry. In such cases, irrigation is advisable.

'Ottawa 3'

Created at the Ottawa Research Station, this new rootstock is the result of a cross between 'Robin' and 'Malling 9' (1956). From 1967 to 1973, it was tested at Ottawa and at Smithfield, Ontario. Multiplied and assessed at the Frelighsburg sub-station since that time, it has been distributed to a number of nurseries across Canada to meet the growing demand from apple growers.

'McIntosh' and 'Quinte' cultivars grafted onto 'Ottawa 3' since 1967 have remained dwarf trees, slightly smaller than on 'Malling 26' but somewhat

larger than on 'Malling 9'. At maturity, a 'McIntosh' apple tree on 'Ottawa 3' can be maintained at a height of slightly less than three metres; the fruit is therefore very easy to pick (Granger *et al*, 1974).

'Ottawa 3' has proven very hardy, comparing favourably to '*Malus robusta* 5'. In the eastern part of the country, apple tree survival, under unfavourable climatic conditions, has sometimes been ensured by the hardiness of their rootstocks. These conditions may still prevail. It is therefore important to use hardy rootstocks wherever possible.

'Ottawa 3' has provided very good yields, considering the small size of the trees it produces. For instance, two-year-old 'Quinte' and 'McIntosh' trees on 'Ottawa 3', planted in 1967 at Ottawa, began to bear in 1970 (4th season), producing an average yield of 5.45 kg per tree and reaching 18 kg in 1972 and 1973 (6th and 7th seasons). Yields from apple trees grafted onto 'Ottawa 3' have thus proven superior to those from apple trees on 'Malling 26'. In addition, 'Ottawa 3' has produced 'McIntosh' and 'Quinte' apples somewhat earlier than 'Malling 26', but the quality of the fruit produced on both rootstocks has been excellent. At the Frelighsburg sub-station, the results obtained with 'Ottawa 3' have been similar to those cited above. However, with the training systems most appropriate to it, 'Ottawa 3' has shown better performance at Frelighsburg than at Ottawa. In fact, table 2 shows that with 'McIntosh' and 'Spartan' cultivars and trees trained to the four methods mentioned at the beginning of this article, 'Ottawa 3' is easily the best rootstock for producing high, early yields of quality fruit.

The training system which appears best suited to 'Ottawa 3' is the "slender bell" (Tables 6 and 7).

TABLE 6 Average production (kg/ha) of dwarf and semi-dwarf 'Spartan' apple trees with "slender bell" (1) and "oblique palmette" (2) training systems, 4th season, Frelighsburg 1979

Rootstock	Density trees/ha				Average	
	2960		1480			
	(1)	(2)	(1)	(2)	(1)	(2)
Ott 3	15170 a	13287 a	11350 a	7625 a	13260 a	10458 a
M 9	15537 a	9048 b	7448 b	3643 c	11493 b	6346 b
M 26	8962 b	6029 c	5347 c	5260 b	7155 c	5645 c
M 7	6621 c	7790 d	3825 d	1370 d	5223 d	4580 d

a Non-significant difference (at the 5 % level) from data followed by the same letter.

TABLE 7 Average production (kg/ha) of dwarf and semi-dwarf 'Spartan' apple trees with "free-standing" (1) and "Van Roechoudt palmette" (2) training systems, 4th season, Frelighsburg 1979

Rootstock	Density trees/ha				Average	
	1480		740			
	(1)	(2)	(1)	(2)	(1)	(2)
Ott 3	8242 a	7807 a	3280 a	5019 a	5761 a	6413 a
M 9	7886 b	3520 c	3125 a	2309 b	5505 a	2915 b
M 26	4141 c	4590 b	5820 b	1498 c	4980 b	3044 b
M 7	3224 d	1361 d	1580 c	598 d	2411 c	978 c

a Non-significant difference (at the 5 % level) from data followed by the same letter.

With this training system, however, and high-density planting, the 'Spartan' cultivar on 'Ottawa 3' has not proven to be significantly superior to 'Malling 9'. At this density, 'Spartan' fruit on 'Ottawa 3' has tended to be small, thus reducing the weight of the crop. The training system least suited to the 'Spartan' cultivar on 'Ottawa 3' is that of the unsupported "free-standing" tree (Tables 6 and 7). This indicates that an apple tree comprised of the 'Ottawa 3' rootstock needs

a stake or some form of support. Measurements of the trees on our Frelighsburg plots confirm the above observations, that 'Ottawa 3' gives the apple tree a degree of vigour between that of 'Malling 9' and 'Malling 26' (Table 4). It should be noted that too high a density (regardless of the training system adopted) is likely to reduce the vigour of apple trees on 'Ottawa 3' (Table 4). In general, medium densities (all training systems combined) allow 'Ottawa 3' to achieve its optimum physiological equilibrium. It attains its maximum performance, that is, each individual tree produces its heaviest yield, with the "slender bell" training system and medium density (1480 trees per hectare). However, the highest yields per hectare were obtained when 'Spartan'/'Ottawa 3' trees were planted at high density, even though, under these conditions, the average yield per tree was lower (Tables 6 and 7). 'Ottawa 3' also appears to be as good a rootstock for the 'McIntosh' cultivar as for the 'Spartan' cultivar, whereas both 'Malling 26' and 'Malling 9' proved less satisfactory as rootstocks for 'McIntosh' than for 'Spartan' (Table 3). However, without irrigation and chemical thinning, 'McIntosh'/'Ottawa 3' and 'Spartan'/ 'Ottawa 3' trees tend to produce rather small apples (Table 5).

Used as an 8 to 10 inch interstock on the *Malus robusta* 5 rootstock, 'Ottawa 3' has given excellent early yields at Ottawa and at Frelighsburg. 'McIntosh' and 'Quinte' cultivars grafted in this way have given approximately twice the yield per tree of the same cultivars grafted directly onto 'Ottawa 3' roots. 'Ottawa 3' has proven superior to 'Malling 26' when used as an interstock on '*Malus robusta* 5'.

To date, 'Ottawa 3' does not appear to be overly sensitive to virus diseases. In certain cases, however, scions, including those of non-indexed 'Jerseymac' and 'Macspur', have transmitted virus diseases to it, with symptoms appearing at the graft point in the form of brown streaks below the bark. Trees thus affected will die within a relatively short time. In addition, in the nursery, this clone is extremely sensitive to powdery mildew and the woolly aphid.

These disadvantages would be more or less negligible in the orchard, but apple growers and nurserymen should nonetheless be advised to graft onto 'Ottawa 3' only those scions which have been indexed for the principal virus diseases.

Multiplication of 'Ottawa 3' from stool bed layering is very difficult, but relatively easy from root cuttings. Root cuttings of 'Ottawa 3' kept in the greenhouse from February to May at the Saint-Jean Research Station showed rooting rates of 600 and 850 per 1000 in 1972 and 1973 respectively. When propagated by means of soft wood cuttings, this clone showed a rooting rate of from 62 to 65 % from 1969 to 1974. This percentage is lower than that obtained with *Malus robusta* 5 but higher than that obtained with 'Malling 7'.

'Malling 7'

This rootstock, known in France and England since the seventeenth century, was reselected in 1959 by England's East Malling Research Station (Tukey, 1964). It is the only rootstock currently available on a world-wide basis which produces a semi-dwarf apple tree.

'Malling 7', as one of the oldest rootstocks in use by apple growers, is considered one of the safest in North America because it has performed well under a multitude of soil and climate conditions. In Massachusetts and in Michigan, it still plays a major role in new plantings. No supports are used, and the trees receive minimum maintenance. 'Malling 7' is precisely the rootstock which can nevertheless perform profitably under these conditions (Lord and Costante, 1977). With 'Malling 7' as the rootstock, unsupported trees given practically no pruning and allowed to grow with no particular care in poorly drained, weedy soil have performed well since 1957 at Frelighsburg (Granger, 1972). In their 9th and 10th seasons, Melba, McIntosh and Bancroft cultivars on 'Malling 7' have had low yields of from 20 304 to 38 394 kg/ha (average for the two years and three cultivars combined) but the fruit was of excellent quality.

At low density, per-hectare yields of apple trees grafted onto '*Malus robusta* 5' have been slightly higher than those of trees grafted onto 'Malling 7', at 18 770 as opposed to 18 246 kg/ha. However, at maximum density, the yields of cultivars on 'Malling 7' have been superior to those of cultivars on '*Malus robusta* 5', the difference being in the range of 1 778 kg/ha in favour of 'Malling 7' for the 9th and 10th seasons combined. More recent observations at the Frelighsburg sub-station have shown that, of the 4 rootstocks tested, 'Malling 7' has produced the lowest yields at both high and low density, except with 'McIntosh', which, when grafted onto 'Malling 7', produced more apples than when grafted onto 'Malling 9' or 'Malling 26' (Tables 2 and 3). 'Malling 7' thus appears to be better adapted to 'McIntosh' than 'Malling 9' or 'Malling 26' (Table 3). We have observed that the training system best suited to 'Malling 7' is the "slender bell" and that, even with this rootstock, it is important to support the trees; otherwise, yields decline (Tables 6 and 7). Finally, 'Malling 7' has proven more vigorous than the other four rootstocks and has produced the largest fruit (Tables 4 and 5).

Malling 7 has a taproot system, rather than a running root system as is the case with the other three rootstocks discussed. As a result, it may, at least under certain conditions (partial freezing of its roots, etc.), suffer from a potassium deficiency. In addition, it has a strong tendency to produce suckers and it has proven very sensitive to crown gall *(Agrobacterium tumefaciens)* (Pl. III, fig h). While the use of this rootstock may seem to be an easy solution to many apple growers in Québec in view of observations in Massachusetts and elsewhere, a word of warning is necessary; certainly 'Malling 7' is a reliable rootstock for the apple grower who wishes to obtain small or medium yields with minimum effort. However, 'Malling 7' is totally inadvisable for those who wish to obtain volume and quality, or, in other words, to achieve maximum profit form their operations. Tests performed at Vineland, Smithfield, Saint-Jean and Ottawa show the relatively low productivity of Malling 7 (Hutchinson, 1964).

Pear rootstocks

The most popular rootstock for pear in Québec is still the 'Bartlett' ('Williams') seedling. Although it is fairly slow to come into bearing and relatively sensitive to bacterial fire blight (*Erwinia amylovora* Burr. Winsl. *et al*). This type of rootstock has proven hardier and more vigorous than certain quinces which are not adapted to our climate, particularly quince C. However, *Pyrus Ussuriensis* has been a good reliable and cold hardy rootstock in the province of Québec.

The Angers quince, which is considered relatively hardy in Ontario and at the Geneva, NY research station (Lapins, 1963), has received only limited testing in Québec. 'Bartlett' seedlings have proven compatible with Québec's most popular cultivars, 'Flemish Beauty', 'Clapp's Favourite', 'Anjou', 'Bosc' and 'Bartlett' (Pl. III, figs. b, c, d). The latter, because it is not a hardy variety, has not been profitable in Québec.

Since 1972, we have been testing native hawthorn seedlings (*Crataegus* L.) at Frelighsburg in an attempt to produce earlier-bearing dwarf pear trees. We have found the life expectancy of pear scions on hawthorns to be extremely short. In general, a combination of this kind lasts only about five or six years. We then began testing interstocks of 'Old Home' on *Crataegus* roots. According to results obtained in Oregon, this combination should produce a certain degree of resistance to bacterial fire blight (*Erwinia amylovora* Burr. Winsl. *et al*), earlier fruiting and moderate dwarfism. Unfortunately, the rooting rate for trees with these double grafts has been only 25%; however, those specimens which took root have performed well, have begun to bear early and have developed into semi-dwarf pear trees. The best combination has been the scion on 'Old Home' on seedling stock. As a result of these tests, some of our nurseries have begun to use 'Old Home' as interstocks on seedlings. Preliminary trials have indicated that 'Harbin' and 'Luscious' could be possibly used as rootstocks for pear in Québec. We have not yet tested any of the

Russian or German rootstocks, such as the 'Melitopolskaya' and 'Severnaya' quince, and the 'Pillnitz' #1, 3 and 5 quince selections or 'Pillnitz' clones *(Pyrus betulifolia)*, which are recognized as relatively dwarfing and cold-hardy.

Plum rootstocks

For over half a century, the rootstocks most commonly used in Québec for plums have been native plum seedlings *(Prunus americana)* and East Malling's 'Myrobolan B'. With these rootstocks, plum trees are planted at a density of approximately 450 trees per hectare. At the La Pocatière and Frelighsburg sub-stations, we have planted plum trees grafted onto 'Brompton' rootstocks at a density of 840 trees per hectare. This experiment, begun in 1977, involves more than 30 plum cultivars on this rootstock; these trees have begun to bear but it is still too early to assess the results obtained.

At the Ottawa, Vineland and Geneva research stations, tests have dealt with the dwarfing effect of sand cherry seedlings *('Prunus besseyi')* used as rootstocks (Blair, 1954; Hutchinson, 1964). Yields have proven acceptable, the fruit has matured from 7 to 10 days earlier and quality has been excellent. However, the trees have required solid supports and it appears that 'Damson'-type scions are incompatible with these rootstocks. At the Frelighsburg sub-station, we have grafted plum trees onto *'Prunus tomentosa'* but the survival rate was only 15 %. These trees were approximately half the size of standard trees and could have been planted at densities in excess of 1 500 trees per hectare.

Sweet and sour cherry rootstocks

The commonest rootstocks for sour cherry cultivars in Québec are 'Mazzard' and 'Mahaleb' seedlings and the 'Mazzard F12' clone. While 'Mahaleb' seedlings are slightly dwarfing for such sour cherry cultivars as 'Montmorency', 'Northstar' and 'Meteor', they still produce trees which

are rarely smaller than 50 % to 75 % the size of standard trees. Lapins (1963) reports that an interstock of the wild red cherry *('Prunus pensylvanica')* on a 'Mazzard' root has a strong dwarfing effect and is compatible with the principal commercial sour cherries. At the Frelighsburg sub-station, we have performed a number of tests with wild red cherry seedlings which have always appeared to be compatible with scions of commercial sour cherries. However, it is still too early to evaluate the results obtained. Since we have not yet tested the English dwarfing rootstalk 'Colt', we have no rootstocks which really allow us to plant sweet and sour cherry trees (for amateur gardeners) at high densities in Québec.

Economic aspects

Although it is still too early in Québec to be able to evaluate the profitability of various forms of fruit trees cultivated at given densities, the preliminary results obtained in our experimental plots and by avant-garde producers show promising results. Moreover, Fisher (1969) in British Columbia, Norton (1971) in the State of New York and Hutchinson (1976) and Miller (1976) in Ontario have reported that, even in America, high-density orchards were more profitable than conventional orchards. Of course, according to the same researchers, excessively dense plantings are no more profitable than those which are not dense enough.

For apple trees, the results from our experimental plots at Frelighsburg show that for the year 1979 (4th season) the "slender bell" training system with high-density planting was the most profitable combination (profit of 2 042,50 $ per hectare). It was followed by the "oblique palmette" system at high density (profit 1 457 $ per hectare). It is difficult to predict, from the data currently available to us, when our apple trees will reach the break-even point. We anticipate that, as the rate they are progressing and with the best possible combination, that is, 'McIntosh' or 'Spartan' on 'Ottawa 3', planted at high density with the slender bell system, by the 6 th season we shall completely cancel out

the initial debt of 16 342 $ per hectare which it cost to establish and maintain this system to 1979. In short, production from these trees will have to rise from 9220 kg/ha to approximately 40 000 kg/ha in 1981. Certainly, the free-growing trees have been the cheapest to establish and maintain, but it does not appear that they will be the most profitable. Some apple growers using the "slender bell" system and high-density planting have informed us that their apple trees have reached the break-even point in their 6th season. Some, according to our crop estimates, have produced, with their fifth - and sixth-season dwarf apple trees, between 30 000 and 45 000 kg/ha from "slender-bell" 'Spartan', 'McIntosh', 'Lobo' and 'Red Delicious' cultivars planted at 2 000 to 3 000 trees per hectare. At this rate, if it is true that the Québec apple grower must produce 20 000 bushels of apples in 1980 in order to earn a satisfactory income, he would need only 20 acres (8.1 hectares) of "slender bell" apple trees planted at high density to earn such an income by the 6 th or 7th season.

As regards Québec's production of pears, plums and cherries, our production volume has been so low, at least in recent decades, that statistical surveys do not even mention these crops. However, in 1976, per capita consumption in Québec was 7.2 lbs of pears, 2.2 lbs of plums and 1.9 lbs of cherries (sweet and sour), as compared to 41 lbs of apples. Our market could thus absorb a good volume of locally produced pears, plums and cherries, provided the fruit is of satisfactory quality.

Under our climatic conditions, the pear cultivars which could supply the local market with fruit which is competitive in terms of production and quality (Pl. III, figs.b, c and d) are 'Clapp's Favourite', 'Flemish Beauty', 'Beurrée d'Anjou' and 'Miney'. While 'Bartlett' is a better known cultivar in this province, it is a much more uncertain crop since the tree is sensitive to freezing and to bacterial fire blight.

As regards plums, the hardy cultivars most likely to find buyers on the local market are 'Mount Royal', 'Reine Claude de Montmorency' and

'Damas Bleue'*. Many other cultivars could become commercially acceptable since they have produced good yields and quality fruit in Québec (Pl. III, figs e, f and g). A bulletin on plum growing in Quebec is currently being prepared at the Saint-Jean Research Station; it will contain further information on this subject.

We are still far from commercial production of sweet and sour cherries since these crops, particularly sweet cherries, are very marginal. However, the production of sour cherries could be intensified in the Lower St Lawrence and even in other areas where it currently exists in an ambryonic state and where 'Montmorency', 'Meteor' and 'North Star' cultivars have proven to be well adapted (Pl. III, fig. a). Since competition in the area of sour cherry production in North America is very strong, a serious study of the potential market for this fruit in Quebec is essential before we recommend the establishment of commercial orchards.

* note that 'Damas Bleue', a selection of 'Damson', has a higher quality than most plums of the 'Damson' series.

Appendix

Questions and answers on slides shown at the Amarc pavillon August 21, 1980

Q. In the apple cultivars used in Québec, what type of fruiting habits do we encounter ?

A. The fruiting habits which we find are:

a) Type I Spur types (Pl. I, figs. a and b)

b) Type II 'McIntosh' and 'Spartan' types (Pl. I, figs. c and d)

c) Type III 'Empire' and 'Golden Delicious' types (Pl. I, fig. e)

d) Type IV 'Cortland' and 'Red Haralson' types (Pl. I, figs. f and g)

These types correspond more or less to those described by Mr. Lespinasse. Because of the way in which the fruit spurs are arranged in the branches of each type of tree, they require four different types of orchard management (pruning and training).

Q. In Québec, is it more important to drain orchard soils for dwarf apple trees than for standard size trees ?

A. Because of the heavy precipitation in the form of snow and rain, it is absolutely essential to provide good drainage for orchard soils in Québec and particularly for dwarf apple trees, since with these trees the damage potential from successive freezing and thawing of the roots of the tree is a much greater problem when the soil is waterlogged. Since dwarf apple trees have a relatively shallow and undeveloped root system, they are often more subject to root asphyxiation as a result of excess surface water (Pl. II, fig. a).

Q. Is it necessary to irrigate dwarf apple trees ?

A. Apple orchards in Québec receive heavy precipitation each year but unfortunately this precipitation is not uniformly distributed. As a result, in the great majority of cases, irrigation is necessary, at

least during the first few years; the root system of young apple trees is undeveloped and incapable of locating the soil water reserves, which, during dry periods, may be fairly deep. It is important to note that the physiological balance of a dwarf apple tree is much easier to maintain when irrigation is used, and therefore the trees bear sooner and more heavily. In addition, some new cultivars, such as 'Spartan', 'Empire' and 'Red Haralson', require the use of an irrigation system if they are to produce large fruit (Pl. II, fig. b).

Q. Should we avoid planting dwarf apple trees because, in our climate, the branches of the young trees are often cracked or broken by ice, snow and freezing rain ?

A. Certainly branch damage by ice, snow and freezing rain is a problem in Québec but, in general, it is not very extensive. Then too, even standard apple trees, when they are young, can be damaged by ice, snow and freezing rain. To avoid this difficulty, it is a good idea to use good supports or a strong bracing system. Trees with little or no support are much more seriously affected by this kind of mechanical damage. A careful apple grower, when a thaw occurs during the winter, will clear any soft snow from the branches of the apple trees. Once this snow has hardened, it is impossible to free the branches. In addition, when the melting snow freezes, it puts a great deal of pressure on the branches at the crotch. Another phenomenon may also occur in the spring when the snow melts, leaving an empty space below the layer of ice which surrounds the branches of the apple tree. When this happens, the weight of the ice, which does not melt as quickly as the snow, may cause the branches to bend and crack (Pl. II, fig. e).

Q. Is damage caused by field voles and deer more of a problem with dwarf apple trees ?

A. Given the high density and small size of apple trees in new plantings, they are certainly much more vulnerable to damage from these two pests. It is therefore important to protect the apple trees from them.

Q. Are dwarf apple trees more sensitive to bacterial fire blight than standard size apple trees ?

A. Bacterial fire blight is no more of a problem with dwarf apple trees than with standard trees so long as nitrate the fertilizers are not used to excess, extremely sensitive cultivars are avoided ('Yellow Transparent', 'St Lawrence', etc.) and sources of contamination are eliminated. Bacterial fire blight can be spread from one source of infection by summer pruning, which is used on dwarf apple trees as well as standard size apple trees.

Q. Is plum growing feasible in Québec despite the diseases which affect this crop ?

A. Despite the presence of black knot *(Dibotryon morbosum)*, crown gall *(Agrobacterium tumefaciens)* and various virus diseases, plum growing is possible in Québec. Precautions can now be taken against these diseases. A bulletin currently being prepared at the Saint-Jean Research Station deals with plum growing in Québec and with methods of controlling these diseases.

Q. How can you prevent scion-rooting with a dwarfing rootstock ?

A. Scion-rooting, that is, the formation of roots from the scion, can be avoided when planting the apple tree by placing the zone of the graft at least 10 centimetres above ground level (Pl. II, fig. c). If the graft point is accidentally placed below ground level and roots have begun to develop, these roots must be cut as soon as possible and the graft area completely exposed. If they are not removed, the scion roots will completely kill the dwarfing rootstock within one or two years (Pl. II, fig. c).

Q. Is weeding important around a dwarf apple tree ?

A. In our experimental plots at Frelighsburg, we have observed that where weeds have been allowed to grow near the trunks of young apple trees, they have developed very poorly and have not even begun to fruit by their fourth season. However, in the same experimental plots where we have completely cleared the soil by means of chemical weed treatments, for the entire growing season or for part of it, that is, until mid-August, the development of the trees in both cases has been 2 to 3 times better than that of the unweeded apple trees and production has ranged from 5 to 12 kilograms of fruit per tree for 'McIntosh', 'Jerseymac' and 'Red Delicious' cultivars.

Q. Is there any way of eliminating burr knots on certain apple rootstocks ?

A. There has been relatively little research in this area. However, Dr. C.G. Forshey and Mr. F. McNicholas, in eastern New York State, have found that applications of 1 % naphthaleneacetic acid (NAA) have prevented the development of burr knots on 'M 26' rootstocks (Pl. II, fig.d). More details on burr knots were given previously in the section dealing with 'Malling 26'.

Q. Is the south west injury a problem with young dwarf apple trees in Québec ?

A. The south west injury or 'sunscald' is often a very serious problem with young apple trees in Québec. To prevent this difficulty, we advise placing the supports on the southwest side of the tree during planting, or painting the trunk of the apple tree with a mixture of exterior white latex-type paint diluted with 2 quarts of water per gallon, to which 2 lbs of Thiram (75 % WP) in the form of absorbent powder have been added. The Thiram acts as a repellent against field mice (field voles).

Q. What are the most common deficiencies affecting young dwarf apple trees in Québec ?

A. The south west injure or 'sunscald' is often a very serious problem with young apple trees in Quebec. To prevent this difficulty, we advise placing the supports on the southwest side of the tree during planting, or painting the trunk of the apple tree with a mixture of interior or exterior white latex-type paint of the lower quality grade diluted with 2 quarts of water per gallon, to which 2 lbs of Thiram (75% W.P.) in the form of absorbent powder have been added. The Thiram acts as a repellent against field mice (field voles).

N.B. The expensive high quality latex paint may content a mildewcide (alkyl, alkyd etc.) which is phytotoxic. Avoid using these formulations on fruit trees.

Q. What are the most common deficiencies affecting young dwarf apple tree in Quebec?

A. In Quebec, magnesium and boron deficiencies are very common (Pl. II, Figs. h, i). Occasionally there is a calcium deficiency. Consult the Guide de la Culture du Pommier du Québec (Guide to apple growing in Quebec) for more information on this subject (Publication 333, Quebec Department of Agriculture Agdex 211/20).

Q. Should you use a windbreak to protect new plantings of dwarf apple trees in Quebec?

A. The use of a windbreak is essential in Quebec apple orchards. The windbreak should be on the west side of the orchard, towards the prevailing wind. However, apple trees should not be planted too close to the windbreak where the snow which accumulates during our winters will soon break the branches of the apple trees. A good windbreak could be composed of a row of deciduous trees and a row of evergreens planted behind them in a staggered arrangement.

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Plate I

Fruiting habits and forms of apple trees in Québec

a. 'MorSpur McIntosh'/'*M Robusta* 5', 8th season
b. Branches of 'Mac Spur McIntosh'
c. 'Imperial Allred McIntosh'/'Ott 3', 4th season
d. 'Spartan'/'M 26', 4th season
e. 'Empire'/'Ott 8', 8th season
f. 'Red Haralson'/'Ott 8', 8th season
g. 'Cortland'/'M 9', 22nd season
h. 'Imperial Allred McIntosh'/'Ott 3', "slender bell" training system, 4th season
i. 'Golden Delicious'/'M 9', "Van Roechoudt palmette" training system, 6th season
j. 'Spartan'/'Ott 3', "oblique palmette" training system, 4th season
k. 'Imperial Allred McIntosh'/'Ott 3', "free-growing" tree


a


b


d


e


f


g


h


i


j


k

Plate II

Some anomalies or problems in high-density orchards in Québec

a. Poor surface drainage, June
b. Feeder, drip irrigation system
c. Scion-rooting of an 'Imperial Allred McIntosh'/'M 26' apple tree
d. Burr knots on 'M 26'
e. Broken branches on a 'McIntosh'/'M 9' after its 15th season
f. Free-standing 'Spartan'/'M 9' apple tree
g. Leader bending under weight of apples because tree's support is too short
h. Magnesium deficiency
i. Boron deficiency


b


c


d


e


f


g


h

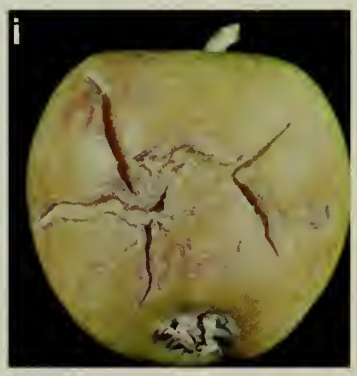
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Plate III

Cherries, pears, plums and crown gall

a. 'Montmorency' sour cherries

b. 'Clapp's Favourite' pears

c. Pear tree, cultivar 'Clapp's Favourite'

d. 'Miney' pears

e. 'Early Italian' plums

f. 'Kahinta' plum

g. 'Kahinta' plum tree, 8th season

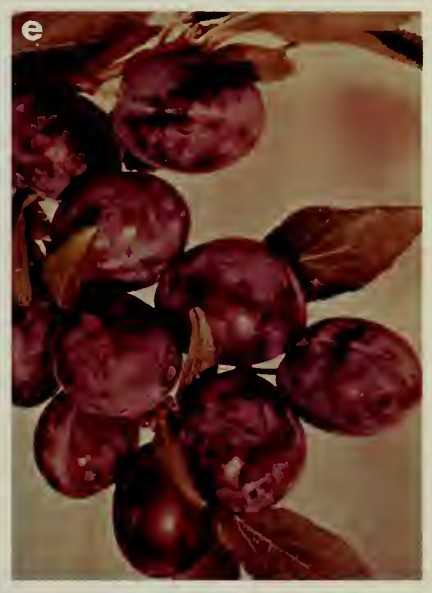
h. Crown gall on roots of 'Brompton' plum trees


a
MONTMORENCY


b


c


d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