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Comparison of 'Pioneer Mac' and 'McIntosh' Apples[1]

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Abstract

A planting was established to compare 'Pioneer Mac,' 'Marshall McIntosh,' and 'Rogers Red McIntosh' apple trees. After eight growing seasons, 'Pioneer' trees were the largest. Cumulative yield per tree was greatest for 'Pioneer' and least for 'Marshall', with 'Rogers' intermediate; however, cultivar differences were significant in only one of the six fruiting years. Cumulative yield efficiency was not affected by cultivar, nor was average crop load. Average fruit weight was greatest for 'Rogers,' with 'Marshall' and 'Pioneer' similar and significantly less. 'Marshall' fruit developed red color over a larger percentage of the surface than the other two cultivars. Ripening, as measured by internal ethylene levels, was earliest for 'Marshall' in two of four years, but in all years, 'Pioneer' and 'Rogers' ripened similarly. Fruit abscission was earliest from 'Marshall' trees in both years of assessment. In one year, 'Pioneer' fruit dropped later than 'Marshall' but similarly to 'Rogers,' and in the second year, 'Pioneer' fruit dropped similarly to 'Marshall.' These data suggest that 'Pioneer Mac' provides no expansion of the 'McIntosh' harvest season.

Introduction

Of the 8,500 ha of apples trees in New England, approximately 52% or 4,400 ha are 'McIntosh' (5). 'McIntosh' originated as a chance seedling discovered by John McIntosh in 1811 in Dundela, Ontario, Canada (7). It was well suited to New England conditions, since cool nights during ripening are required to develop attractive red color. Its prominence was established in New England following the harsh winters of 1933-34 and 1942-43 when many 'Baldwin' trees were lost to cold injury (6). Since that time, the more winter hardy 'McIntosh' has dominated New England production.

McIntosh is particularly prone to preharvest drop before adequate red color or eating quality develop. Also, in New England, much fruit drop can occur because inadequate quantities of labor are available to harvest 4,400 ha in a brief harvest window. Daminozide was used regularly during the 1970's and 1980's to delay abscission, but with the loss of daminozide, much interest was placed on other approaches of enhance the development of color or delaying the harvest season.

Lord (3), Lord et al. (4), and Autio et al. (2) described 'Marshall McIntosh,' a strain discovered at Marshall Farm in Fitchburg, MA in 1967. This strain ripened, and more importantly, colored significantly earlier than standard strains of 'McIntosh.' Many trees of 'Marshall' were planted in New England in the 1980's and early 1990's to gain an advancement in the harvest season. Problems with storability, as described by Autio et al. (2), inadequate tree vigor and fruit size, and enhanced susceptibility to winter damage have reduced the number of 'Marshall' trees being planted.

'Pioneer Mac' is a seedling of 'McIntosh' discovered in 1976 by Ernest Greiner in Marlboro, NY (1). The fruit of this cultivar is indistinguishable from 'McIntosh' and was reported to ripen and drop later than standard 'McIntosh' strains (1).

The objective of this study was to compare tree size, yield, and fruit characteristics of 'Pioneer Mac,' with 'Marshall McIntosh' and 'Rogers Red McIntosh' (a standard strain) to determine if a commercially viable expansion of the harvest season could be achieved while maintaining good yields and fruit quality.

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Table 1. Size, cumulative yield, and average crop load 'Marshall McIntosh,' 'Pioneer Mac,' and 'Rogers Red McIntosh' trees planted in 1988.[z]

Cultivar	Trunk cross-sectional area (cm^2, Oct. 1995)	Cumulative yield per tree (kg, 1990-95)	Cumulative yield efficiency (kg/cm^2 TCA, 1990-95)	Average crop load ($no./cm^2$ TCA, 1990-95)
Marshall	35.4 b	110 b	3.18 a	6.45 a
Pioneer	44.4 a	147 a	3.39 a	7.31 a
Rogers	36.4 ab	139 ab	4.02 a	7.61 a

[z]Mean separation within columns by Duncan's New Multiple Range Test ($P = 0.05$).

Materials and Methods

A trial was established in April 1988 at the University of Massachusetts Horticultural Research Center in Belchertown, MA. 'Pioneer Mac,' 'Rogers Red McIntosh,' and 'Marshall McIntosh' trees on M.26 EMLA rootstock were planted on a west-facing slope in a Montauk fine sandy loam, with the graft union about 10 cm above the soil surface. The experimental design was a randomized-complete-block with 12 replications. A single tree of each cultivar was included within each replication. A 2.5-cm conduit pipe was driven into the soil beside each tree, extending 2.5 m above ground to serve as trunk support. Trees were maintained with central leaders, with minimal pruning during the dormant season only. Nutrient and pest management were per local recommendations.

Trunk circumference 45 cm above the graft union was initially taken in the spring of 1988 and then measured each October and converted to trunk cross-sectional area (TCA). Total yield per tree was assessed each season from 1990 through 1995.

A 20-apple subsample of fruit was collected on 22 Sept. 1992, 14 Sept. 1993, 20 Sept. 1994, and 22 Sept. 1995 randomly from each tree and weighed to estimate average fruit weight. In 1992-93, the percent of the surface which was red in color was estimated from these same 20 apples. Four fruit per tree were harvested randomly on 18 and 25 Sept. 1990; 10, 17, and 24 Sept. 1991; 11, 18, and 25 Sept. and 2 Oct. 1992; and 14, 21, and 28 Sept. 1993. A 1-ml sample of internal atmosphere was extracted from each fruit using a syringe inserted through the calyx opening. The ethylene concentration of this sample was measured using a gas chromatograph equipped with a 0.30 x 50 cm activated alumina column and a flame ionization detector. The average date of ripening was assessed by first transforming ethylene concentrations (ppm) to log values. These values then were averaged for each tree, and relative ripening was determined by interpolating the date when the average of these logged values reached zero.

In 1994 and 1995, fruit were left on the tree to follow natural fruit abscission. Between 16 Sept. and 14 Oct. 1994 and between 14 Sept. and 6 Oct. 1995, dropped fruit were collected under each tree and counted on about a weekly basis.

All data were subjected to analysis of variance. Where year and cultivar interacted significantly to affect the result, the sums of squares for cultivar and the interaction were repartitioned into the effects of cultivar within each year. Cultivar means were separated with Duncan's New Multiple Range Test.

Results and Discussion

Lord et al. (5) and Autio et al. (2) showed significant variation in fruit char-

Table 2. Annual yield (kg/tree) of 'Marshall McIntosh,' 'Pioneer Mac,' and 'Rogers Red McIntosh' trees planted in 1988.[z]

Cultivar	1990	1991	1992	1993	1994	1995
Marshall	0.9 a	4.0 a	14.5 a	7.3 a	27.1 b	56.2 a
Pioneer	1.3 a	5.8 a	19.6 a	12.4 a	40.4 a	67.8 a
Rogers	1.0 a	5.7 a	20.7 a	14.2 a	35.7 ab	61.9 a

[z]Mean separation within columns by Duncan's New Multiple Range Test ($P = 0.05$).

Table 3. Weight, red color, internal ethylene, and date of ripening of fruit from 'Marshall McIntosh,' 'Pioneer Mac,' and 'Rogers Red McIntosh' trees planted in 1988.[z]

Cultivar	Fruit weight (g, 1992-95)	Surface red color (%, 1992-93)	Internal ethylene concentration[y] (ppm, 1990-93)	Date of ripening[x] (1990-93)
Marshall	164 b	82 a	2.52 a	9/18 b
Pioneer	162 b	65 b	0.91 b	9/21 a
Rogers	176 a	62 c	0.83 b	9/21 a

[z]Mean separation within columns by Duncan's New Multiple Range Test $P = 0.05$).
[y]Mean ethylene concentrations resulted from harvests of fruit on 18 and 25 Sept. 1990; 10, 17, and 24 Sept. 1991; 11, 18, and 25 Sept. and 2 Oct. 1992; and 14, 21, and 28 Sept. 1993.
[x]Date of ripening was assessed as the date on which the average of the log of the internal ethylene concentrations of fruit from a tree reached 0. This date is roughly equivalent to when the average of the actual internal ethylene concentrations reached 1 ppm.

acteristics among seven strains of 'McIntosh.' Of particular note, 'Marshall McIntosh' fruit were found to color and ripen earlier and were more sensitive to low-O_2 stress than the other strains. Data that were not presented in either paper also suggested that strains differed in tree size and yield. The study reported here includes two 'McIntosh' strains ('Rogers Red McIntosh' and 'Marshall McIntosh') and a seedling of 'McIntosh' ('Pioneer Mac') and as in the two earlier studies, some differences were detected in tree size, yield, and some fruit characteristics.

After eight growing seasons, 'Pioneer' trees were significantly larger than 'Marshall' trees, and 'Rogers' trees were intermediate in TCA (Table 1). Cumulative yield per tree (1990-95) was greatest for 'Pioneer' and least for 'Marshall', with 'Rogers' intermediate (Table 1). However, cultivar differences varied with year (Table 2). Of the six years of cropping, only in one (1994) were differences among cultivars significant. Cumulative yield efficiency was not affected by cultivar, nor was average crop load (Table 1).

Average fruit weight over four years was greatest for 'Rogers,' with 'Marshall' and 'Pioneer' similar and significantly less (Table 3). Over two years of study, 'Marshall' fruit developed red color over a larger percentage of the surface than the other two cultivars (Table 3). 'Pioneer' fruit had slightly, but significantly, more red color than 'Rogers' fruit. Ripening was assessed from 1990 through 1993. Average internal ethylene concentration was greatest for 'Marshall' fruit over all harvests in these four years; however, the differences among the cultivars varied with year (Table 4). Specifically, 'Marshall' fruit had higher concentrations in only two of the four years. 'Pioneer' and 'Rogers' fruit had similar concentrations of ethylene each year. Using the onset of the ethylene climacteric as an estimate of the relative date of ripening, 'Marshall' fruit, on average, ripened 3 days before 'Pioneer' and 'Rogers' fruit (Table 3). However, this difference was significant in only two of the four years of study (Table 5).

'Pioneer Mac' was reported to ripen 10 days later than 'Rogers Red McIntosh' and develop more red color (1). It is interesting to note that very little measurable difference was detected in this study between 'Rogers' and 'Pioneer.' Trees were similar in size and yield. 'Rogers' fruit were somewhat larger and slightly less colored than 'Pioneer' fruit, but they ripened at the same time.

Further, early reports suggested that 'Pioneer' trees had very little preharvest drop,

Table 4. Internal ethylene concentration (ppm) of fruit from 'Marshall McIntosh,' 'Pioneer Mac,' and 'Rogers Red McIntosh' trees planted in 1988.[z, y]

Cultivar	1990	1991	1992	1993
Marshall	5.32 a	6.41 a	2.81 a	0.43 a
Pioneer	0.78 b	3.46 a	0.46 b	0.55 a
Rogers	0.59 b	4.27 a	0.41 b	0.46 a

[z]Mean ethylene concentrations resulted from harvests of fruit on 18 and 25 Sept. 1990; 10, 17, and 24 Sept. 1991; 11, 18, and 25 Sept. and 2 Oct. 1992; and 14, 21, and 28 Sept. 1993.
[y]Mean separation within columns by Duncan's New Multiple Range Test ($P = 0.05$).

Table 5. Date of ripening[z] of fruit from 'Marshall McIntosh,' 'Pioneer Mac,' and 'Rogers Red McIntosh' trees planted in 1988.[y]

Cultivar	1990	1991	1992	1993
Marshall	9/19 a	9/12 a	9/18 a	9/24 a
Pioneer	9/22 b	9/13 a	9/27 b	9/22 a
Rogers	9/22 b	9/13 a	9/25 b	9/23 a

[z]Date of ripening was assessed as the date on which the average of the log of the internal ethylene concentrations of fruit from a tree reached 0. This date is roughly equivalent to when the average of the actual internal ethylene concentrations reached 1 ppm.

[y]Mean separation within columns by Duncan's New Multiple Range Test ($P = 0.05$).

compared to 'Rogers' trees (1). For 'McIntosh' growers in New England, a reduction in the potential for preharvest drop would greatly enhance profitability, since as much as 30% or more of the fruit can be lost before it is possible to harvest it. Unfortunately, no detectible reduction in the potential for drop was seen in this study (Figure 1). In 1994, 'Marshall' fruit dropped earlier and to a significantly higher degree than either 'Pioneer' or 'Rogers' fruit, but 'Pioneer' and 'Rogers' were similar. In 1995, over 60% of the fruit had dropped by 14 Sept., but by this time, 'Marshall' trees had dropped more fruit than 'Rogers' trees, and 'Pioneer' were intermediate. For the rest of the season, the incidence of drop was similar for 'Marshall' and 'Pioneer' both of which had significantly more drop than 'Rogers.'

In New England 'McIntosh' comprises about 60% of the acreage of apples (5). This high concentration on one cultivar, particularly one that is prone to early preharvest drop and poor coloring, makes harvest prior to significant fruit loss extremely important and very difficult. Strains or 'McIntosh'-like cultivars which ripen and drop later than the standard 'McIntosh' strains could greatly enhance the profitability of the New England apple industry. Although there was much hope for and a great deal of planting of 'Pioneer Mac' it appears to not provide the needed expansion of the 'McIntosh' harvest season. Growers must rely instead on plant growth regulators, such as aminoethoxyvinylglycine, or alternative cultivars to provide this expansion.

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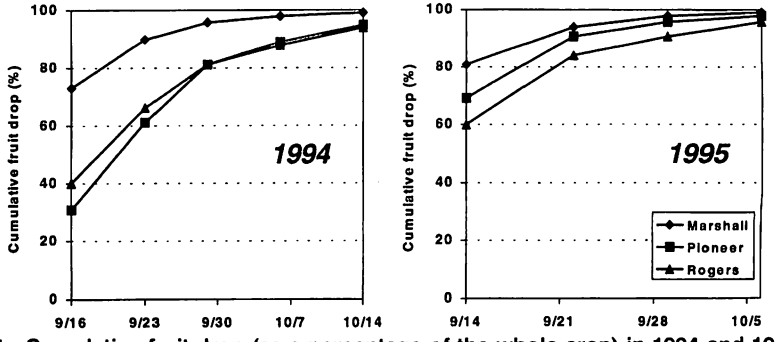

Figure 1. Cumulative fruit drop (as a percentage of the whole crop) in 1994 and 1995 from 'Marshall McIntosh,' 'Pioneer Mac,' and 'Rogers Red McIntosh' trees planted in 1988.