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Field Performance of 'Summerland Red McIntosh,' 'MacSpur McIntosh,' 'Empire' and 'Idared' On Six Rootstocks

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Abstract

Under commercial orchard practice 'Idared' yields were highest for the combined full crop years of 1985 and 1988. 'Empire,' 'Summerland Red (SR) McIntosh' and 'MacSpur (MS) McIntosh' produced less respectively. In 1988 'SR McIntosh' and 'Idared' had highest yields. The 'SR McIntosh' grew the largest; the three other cultivars were smaller and similar in size. Efficiency and crop load was greatest for 'Empire' followed by 'Idared,' 'SR McIntosh,' and 'MS McIntosh.' Irrespective of the cultivar the rootstocks Alnarp 2 (A 2) and Beautiful Arcade seedlings (BA) induced the greatest yield, followed, in decreasing order of magnitude by rootstocks M.25, MM.106, MM.111, and M.7. The largest trees were on BA, while M.25, A 2, MM.111, MM.106, and M.7 were smaller respectively. Yield efficiency and crop load was highest for MM.106 and A 2 and lowest for M.7, and MM.111. Fruit quality was influenced by the cultivar and not by the rootstock. Over the two years, 'Idared' had the highest percent in the large size category of 70 mm, the least for the small category of 57-64mm, and the heaviest average weight. 'Empire' had the fewest in the large category, the highest in the small category and the lightest weight. Red color was highest for 'MS McIntosh' and the least for 'SR McIntosh.'

Introduction

In 1975 when this trial was in the planning stages 'MS McIntosh,' a comparatively recent discovery was being promoted (10) and commecially propagated in large numbers (5). 'Empire,' also a new introduction (12), was being recommended and heavily planted in New York State (15, 1) while 'Idared,' introduced in 1942 (16) ranked third (1) in new plantings.

Apple growers in Nova Scotia, like growers in other regions of North America, had little information on the performance of these new cultivars on the traditional or new rootstocks, Fruit size was also a major concern for the Nova Scotia industry (3). The fact that 'Empire' was found to be a medium sized apple in New York State (14) and was believed to grow smaller in a cool climate (4) added to this concern since the Nova Scotia season season is both short and cool. This added further support to the need for field evaluation. The extent to which semi-dwarf, semi-vigorous and vigorous rootstocks may influence these anticipated problems, under commercial conditions, compared to regular and spur-type 'McIntosh' and the semi-spur 'Idared' is the objective of this study,

Materials and Methods

One year whips of 'SR McIntosh', 'MS McIntosh,' 'Empire,' and 'Idared' were propagated on MM.106, MM.-111, A 2, M.25, M.7 and BA in a Nova Scotia Department of Agriculture and Marketing nursery for this study. The trees were planted in spring 1979 at Coldbrook, Nova Scotia, Canada, in a commercial orchard at 4.3 x 6.1 M spacing on mounded rows. The reasonably level site, was newly cleared of mixed forest in a Cornwallis sand soil area. It was tile drained to correct a problem of uneven internal drainage. The trees of each cultivar were arranged in two adjacent rows of that particular cultivar.

The plots consisted of 7 trees of each rootstock combination. One plot of each rootstock was randomized in each of the two cultivar rows or 14 trees of each cultivar rootstock combination. Since only the rootstocks could be randomized in each row the

trial is classified as a partially randomized split plot design.

Trunk growth and yields were recorded in 1985 and 1988. In 1986 very few apples were harvested because of severe spring frost. In 1987 poor fruit set and light frost greatly reduced a potentially full crop. The 1988 season was favorable and a heavy crop was harvested throughout the region. Immediately prior to harvest and subsequent recording of the yield in 1985 and 1988 a sample of 54 apples was randomly collected from each tree. This was placed in storage and graded at a later date. Trunk circumferences, 30 cm above the ground, were recorded in November 1985 and March 1989. These records were converted to trunk cross-sectional area (TCA).

Results and Discussion

The results are presented for each of the two years the orchard was studied. Consistent patterns of performance over the two years are also highlighted and discussed. No interactions occurred between the rootstock and the cultivar so only the main effects are presented.

Yield. In 1985 cultivars did not differ significantly in yield (Table 1), however the average yield was highest for cultivars on the rootstocks M.25, BA and A 2 (Table 2) at 52, 51 and 50 kg per tree respectively. The rootstock MM.106 was in the middle range and the least productive were those on MM.111 and M.7 at 33 and 30 kg per tree respectively. The highest yielding combination was 'Idared' on A 2, the lowest was 'MS McIntosh' on M.7, (data not shown). In 1988 highest yields were for the cultivars 'SR McIntosh' and 'Idared.' 'Empire' was in the middle range while the 'MS McIntosh' had the least. Yields were highest for cultivars on the rootstocks A 2 and BA (Table 2) at 86 and 81 kg/tree respectively. No differences among the other rootstocks were found. The high yields for A 2 has not been shown earlier. When yield over both years are combined the cultivar 'Idared' is first, followed by 'Empire,' 'SR McIntosh', and 'MS McIntosh.' This agrees with a recent report (12) that 'Empire' has high yield capabilities. The rootstocks rank in the following order: A 2, BA, M.25, MM.106, MM.111, and M.7.

Growth. In 1985 the trees were 7 years old, the average size for all cultivars was 52 cm^2 and since most cultivars were within 4 cm^2 of this, no differences were evident. There were differences between the rootstocks. The largest trees were on BA, A 2 and M.25 at 67, 60 and 56 cm^2 respectively. The rootstocks MM.106, MM.111 and M.7 were all smaller and did not differ from each other. In 1988 the trees were 10 years of age and there were again no differences between the cultivars. The rootstock effects were restricted to BA, the largest, whereas differences between the others were not statistically significant. As trees aged there was a slight shift in vigor ranking for both cultivars and root-

Table 1. Yield, TCA, yearly yield/TCA and apples/TCA of 'SR McIntosh,' 'MS McIntosh,' 'Empire,' and 'Idared' for all rootstocks.

	Yield (kg)		TCA (cm^2)		Yield/TCA		Apples/TCA	
Cultivar	1985	1988	1985	1988	1985	1988	1985	1988
SR McIntosh	32	78	53	98	0.6	0.8	4.5	7.4
MS McIntosh	34	54	48	87	0.7	0.7	5.4	5.8
Empire	52	66	51	89	1.1	0.9	10.4	8.0
Idared	56	76	57	89	1.0	0.8	7.7	6.4
S.E.M.	6.3	3.5	5.0	6.7	0.06	0.07	0.5	0.8

Table 2. Effect of rootstock on yield, TCA, yield/TCA and apples/TCA for all cultivars.

Rootstock	Yield (kg)		TCA (cm^2)		Yield/TCA		Apples/TCA	
	1985	1988	1985	1988	1985	1988	1985	1988
MM.106	45	65	41	81	1.1	0.8	9.1	7.2
MM.111	33	57	50	87	0.7	0.7	5.3	5.7
Alnarp 2	50	86	60	90	0.9	1.1	7.0	9.0
M.25	52	66	56	96	0.9	0.7	7.8	6.1
M.7	30	55	41	77	0.7	0.7	6.1	6.1
BA	51	81	67	112	0.7	0.8	6.7	7.3
S.E.M.	4.7	6.0	4.8	7.4	0.05	0.12	0.5	1.0

stocks. The cultivar 'SR McIntosh' replaced 'Idared' which dropped to second place from first and was the same size as 'Empire' and slightly larger than 'MS McIntosh.' The rootstock A 2 dropped to third place from second behind M.25 the reverse of their earlier rank and below BA. This result is consistent with earlier work that showed cropping reduces growth (6).

Efficiency. In 1985 both 'Empire' and 'Idared' were more efficient (yield/TCA) than the 'McIntosh' clones. The rootstock MM.106 produced the most efficient combinations while A 2 and M.25, were less so but higher than MM.111, M.7, and BA. In 1988 no cultivar or rootstock differences were found. For the two years combined 'Empire' and 'Idared' ranked higher than the two 'McIntosh' strains in yield efficiency. The rootstock A 2 maintained the greatest yield efficiency followed by MM.106, M.25, BA, M.7, and MM.111 respectively.

In Massachussetts the rootstock and interstock were also found to influence efficiency (11).

Apples per cm^2 of trunk. The number of apples per tree was calculated to determine the effect of cultivar and rootstock on crop load. In 1985 'Empire' had the largest number at 10.4. This was similar to the average found by Forshey (6) in a four year trial. 'Idared' had 7.7, 'McIntosh' had the lowest crop load at 4.5 and 5.4 for the 'SR' and 'MS McIntosh' strains respectively and there was no significant difference between the two. The rootstocks MM.106 and M.25 induced the greatest crop load at 9.1 and 7.8. There were fewer apples per cm^2 of TCA on the A 2, BA, and M.7 at 7.0, 6.7, and 6.1 respectively. The fewest number of apples per cm^2 was on the rootstock MM.111 with 5.3 although not statistically different than M.7 or BA. In 1988 no cultivar or rootstock differences were found. When 1985 and 1988 are compared crop load increased for 'SR McIntosh' and stayed about the same for 'MS McIntosh' and declined for 'Empire' and 'Idared.'

This may reflect a cultivar performance trait or may be the result of the heavier pruning and thinning of 'Empire.' From 1985 to 1988 'Idared' crops were more even, perhaps a direct result of its heavier yields during the years of spring frost damage (2).

Size. In 1985 'Empire' had the greatest and 'MS McIntosh' the smallest portion of its sample in the culls and 57 mm and smaller category at 11 and 2 percent respectively (Table 3). 'Idared' had 5 and 'SR McIntosh' had 4 percent in this category. For 'Empire' over half of the sample was graded into the small size category of 57-64 mm. For 'Idared' the percentage in this category was much less at 17,

Table 3. Fruit size, weight and color of 'SR McIntosh,' MS McIntosh,' 'Empire' and 'Idared' for all rootstocks.

	Percent of sample weight in each size class (mm)								Weight (g/apple)		% of sample with red color	
	57 and culls		57-64		64-70		70				60%	40%
	1985	1988	1985	1988	1985	1988	1985	1988	1985	1988	1985	1988
SR McIntosh	4	4	6	27	30	51	60	18	138	110	29	59
MS McIntosh	2	3	10	23	38	54	50	20	129	112	61	93
Empire	11	11	55	40	30	43	4	6	103	104	25	71
Idared	5	3	17	11	32	38	46	48	128	133	33	71
S.E.M.	0.8	1.3	1.8	1.8	2.9	2.1	3.6	3.6	3.9	4.0	2.5	3.3

however this was higher than the 'McIntosh' strains at 10 and 6 for 'MS' and 'SR McIntosh' respectively. There were no differences between the cultivars in the percentage of apples that graded into the 64-70 mm size range. In the large size category of 70 mm and greater, 'SR McIntosh' had the largest percentage in this group at 60 compared to 50 and 46 for the 'MS McIntosh' and the 'Idared' respectively. 'Empire' had only 4 percent of the sample fruit in this category. In 1988 'Empire' again had the largest proportion of its sample in the cull and 57 mm and smaller size range at 11 percent. The other cultivars had about one third this amount and did not differ significantly from each other. The sample had 40 percent of the 'Empire' in the 57-64 mm size category while 'SR' and 'MS McIntosh' had 27 and 23 respectively. 'Idared' had the least with 11 percent. In the next largest size category of 64-70 mm the two 'McIntosh' strains had the largest amounts at 51 and 54 percent for 'Summerland' and 'MacSpur' respectively. 'Idared' had the least of all in this category at 38 although not significantly different than 'Empire' at 43. In the largest category of 70 mm and larger 'Idared' ranked first with 48 per cent of the sample graded into this category. The two 'McIntosh' strains were next and almost identical at 18 and 20 percent while 'Empire' had the least at 6. There were no rootstock effects on fruit size categories in either year. For the two years of the study 'Idared' and 'Empire' performed most consistently having the largest and smallest sized fruit respectively. The average size for the 'McIntosh' strains declined; however, there were still over 70 per cent in the saleable size range of 64 mm compared to only 49 for 'Empire.' In New York, control trees had 19% of the crop in the 70 mm and over category (8). In this trial only 5% grew to this size confirming earlier concern that 'Empire' may produce small size fruit in cooler climates. A reduced crop load and maintenance of tree vigor by the vigorous rootstocks did not significantly overcome the small apple problem. In Massachussetts heavy crops reduced fruit size (11) in 'Empire.'

Weight. In 1985 the apples of the 'SR' strain of 'McIntosh' were the heaviest at 138 grams although not different from 'MS McIntosh' or 'Idared.' 'Empire' were the lightest at 103 grams. In 1988 'Idared' fruit were heaviest at 133 grams. The 'SR' and 'MS' strains of 'McIntosh' and 'Empire' were all lighter and weighed 110, 112 and 104 grams respectively. Over the two years of the study 'Idared' increased in weight; the two 'McIntosh' strains decreased. 'Empire' remained the lightest and almost identical to the first year even though the crop load

declined approximately 20 percent. There was no rootstock effect on fruit weight in either year. This confirms earlier reports that classify this cultivar as one that produces uniform, medium sized fruit (14) and has a spur density that promotes heavy crop loads in relation to leaves and branch circumference (7).

Color. In 1985 'MS McIntosh' produced the largest portion of the sample in the high color range at 61%. The 'SR McIntosh' strain, 'Empire' and 'Idared' had lower color levels at 25, 29 and 33% respectively and they did not differ significantly from each other. In 1988, when the color standard was lowered to 40% (to match commercial practice), 'MS McIntosh' was again superior to the other strains and 93% of the sample was graded into this classification. 'SR McIntosh' had the lowest color at 59 percent of the sample in the packable color range. 'Empire' and 'Idared' had better color and with samples grading an identical 71 per cent into the well colored category. The 'MS McIntosh' strain was consistently better colored each of the two years of the study while the non spur 'McIntosh' strain was the poorest of all cultivars in this study. This supports earlier work comparing spur and non-spur 'McIntosh' (9). 'Empire' and 'Idared' had poorer color levels than the 'MS McIntosh' each year, yet significantly above 'SR McIntosh' only the last year of the study. There was no rootstock effects on fruit color in either year.

Even though rootstocks significantly altered yield, growth, yield efficiency and crop load of the four cultivars they had little influence on fruit weight, size and quality. This illustrates that management practices which are adequate for a spur-type 'McIntosh,' for example, may not be adequate for a non-spur strain and inputs that provide large size 'Idared' will not be adequate for 'Empire.' Specializing cultural inputs for each cultivar will add further complexity for the orchard manager.

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Cultivar Performance on M.9 Rootstock

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A series of cultivars on M.9 rootstock were established at a spacing of 10′ x 18′ in a completely randomized design with the exception of 'Holiday,' which was as two solid rows. The yield performance of these trees was evaluated over 15 years and prior to pulling the trees, canopy height and spread were measured. 'Franklin' produced very large trees compared to all other cultivars. Trees of all cultivars, except 'Holiday' could be managed easily from the ground and the 3-foot wooden post by each tree provided adequate support. 'Starkrimson' and 'Wellspur' tended to be smaller than most of the standard habit 'Delicious' strains. The standard strains 'Hi Early' and 'Imperial' were the most efficient of the 'Delicious' strains. The spur 'Delicious' strains became spur bound and were inefficient, thus the combination of spur habit 'Delicious' on M.9 would not be recommended.

Table 1. Performance of selected apple cultivars and strains of 'Delicious' over 15 years on M.9 rootstock in Wooster, Ohio.

Cultivars	Number of trees	Avg. Trunk cross-sect. area cm^2	Tree Height (ft)		Cumul. yield/ tree (lbs)	Efficiency lbs/cm^2
			Height	Spread		
Golden Delicious	10	76.6	8.4	10.0	601.4	7.8
Melrose	6	69.9	8.6	9.9	565.8	8.0
Franklin	4	160.0	11.7	14.2	797.4	4.9
Holiday	45	58.2	8.5	9.1	423.7	7.2
Delicious Strains						
Gardner	5	69.0	10.2	10.9	387.2	5.6
Hi-Early	5	75.0	11.0	12.9	628.0	8.3
Imperial	4	72.7	7.5	11.2	576.6	7.9
Chelan Red	4	76.8	9.4	12.1	504.5	6.5
Rypcynski	4	85.2	9.6	11.9	639.2	7.5
Starkrimson	6	79.4	7.5	8.4	429.6	5.4
Wellspur	7	58.7	7.1	6.3	228.5	3.8