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STOCK AND SCION INVESTIGATIONS XIV. DELICIOUS APPLE ON MERTON AND OTHER CLONAL ROOTSTOCKS

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SUMMARY

The performance of Delicious apple trees on their own roots and on rootstocks Merton 789, Merton 778, Merton 779, Merton 793, Northern Spy and Essfour was evaluated 15 years after planting.

Tree growth was greatest on Essfour and least on Northern Spy rootstocks whether determined by trunk girth or by height and spread of tree. Largest total crops were borne by trees on the Merton rootstocks and the least crop by Northern Spy. Both Merton 789 and 793 cropped more heavily than Northern Spy in the early bearing years.

On the basis of tree size, the potential bearing surface of trees on the Merton stocks fell into three groups for the Delicious scion: (a), 778 and 779; (b), 793; and (c), 789.

The variety Granny Smith gave a similar-sized tree producing equal amounts of crop on Merton stocks 778 and 793 at 14 years.

Delicious trees on their own roots were less vigorous than those on Essfour and yielded less than those on Merton 793 and 779 rootstocks.

The relative order for vigour of trees in this series of rootstocks was similar for three soil types.

I. INTRODUCTION

The status of Northern Spy as the best rootstock for apple trees in Australia was questioned in the 1930s by orchardists in the Stanthorpe district of south-eastern Queensland when, with certain scion varieties and on some soils, trees on this rootstock failed to produce a framework of sufficient size to bear an economic crop. Alternative rootstocks immune to woolly aphid were sought to remedy this situation. Thomas (1945, 1947) showed that in closely planted

trials, the Merton rootstocks 778, 789 and 793 produced larger trees and larger crops with variety Jonathan than did Northern Spy. Further work on these rootstocks in an orchard planting was undertaken in order to check the results obtained from the closely planted trials to test their relevance for other scion varieties and to gain a more accurate assessment of their influence on growth and cropping under orchard conditions.

II. MATERIALS AND METHODS

Four Merton rootstocks—Nos. 778, 779, 789 and 793—were included in the trial; these were derived from crosses between East Malling II and Northern Spy by Crane in 1922 and were described by Tydeman (1937). Other rootstocks used were Northern Spy, Essfour and Delicious trees on their own roots produced from layer beds. Essfour is a locally selected clone of equivalent vigour to E.M.XII (Thomas 1953) and resistant to woolly aphid.

All rootstocks, including the own-rooted Delicious, were budded to a selected red strain of Delicious apple. There were 22 replicates of trees on each rootstock with the rootstock position chosen at random for each block. Three soil types were distinguishable in the experimental area:—(a) a coarse sandy-clay loam; (b) a loamy coarse sand; and (c) a loamy coarse sand above a coarse sandy clay. There were nine, seven and six replicates respectively on these soil types.

Guard trees of the variety Granny Smith on Merton 778 or Merton 793 were used as pollinators for the Delicious trees.

All trees were planted as whips in 1951 at 20 ft apart.

The trees were pruned to a vase shape at the annual winter pruning. Laterals less than 12 in. long were left unpruned to encourage thickening and the development of spurs; laterals longer than 12 in. were pruned back to five buds. Subordinate leaders were developed during the first 5 years to increase the frame of the tree.

Clean cultivation was practised in summer to control weed growth and a green manure crop of either N.Z. blue lupins or rye was planted in autumn.

A complete fertilizer mixture containing 10% N, 9·8% P_2O_5 and 7·5% K_2O was applied in early spring at the rate of 6 lb per tree Sprays containing zinc, boron and copper were applied as a precaution against nutrient deficiencies of these elements.

All fruit was recorded by weighing the annual crop. Samples picked at random from each tree were used to estimate any change in fruit weights due to season or rootstock.

Trunk girths were measured at 9 in. above the union. The measurement for tree height was the average height of the leaders above the ground. The spread of the trees was determined as the mean of measurements in two directions at right angles to each other. Tree volume was derived from these measurements.

III. RESULTS

Tree growth in Delicious.—Data for tree growth as shown by trunk girth and tree size measurements are given in Table 1.

TABLE 1

APPLE ROOTSTOCK TRIALS: GROWTH MEASUREMENTS (1965)

Rootstock	Trunk Girth (cm)	Height x Spread (sq ft)	Tree Volume (cu ft)
Essfour ..	46·85	108·02	971·2
779	41·30	94·72	795·8
778	40·82	96·97	855·8
Own Roots ..	40·32	83·13	658·2
793	36·18	84·52	712·1
789	34·08	70·39	542·5
Northern Spy	28·99	60·86	443·7
	Essfour≫779≫778≫Own Roots≫793≫789≫Spy 779≫793≫789≫Spy 778≫793≫789≫Spy Own Roots≫793≫789≫Spy 793≫Spy 789≫Spy	Essfour>778≫779≫793≫Own Roots≫789≫Spy 778>793≫Own Roots≫789≫Spy 779>793>Own Roots≫789≫Spy 793≫789≫Spy 789>Spy	Essfour≫779≫793≫Own Roots≫789≫Spy 778>793≫Own Roots≫789≫Spy 779>Own Roots≫789≫Spy 793≫789≫Spy Own Roots≫Spy

Trees on the very vigorous rootstock Essfour had the largest girths and those on Northern Spy the smallest girths.

The Merton rootstocks induced greater vigour in the Delicious scion than did Northern Spy. This has already been demonstrated for variety Lane's Prince Albert by Tydeman (1940) and for variety Jonathan by McKenzie (1964) and Thomas (1945, 1947).

There is a close relationship between trunk girth and tree size as measured by height and spread. McKenzie (1964) suggested that tree volume may be a more reliable indication of tree size than trunk girth. From the data in this trial it appears that tree volume is not so closely correlated with trunk girth, height and spread measurements.

The Merton series of rootstock exhibit three classes for vigour with the Delicious scion:—(a), 778 and 779 (maximum vigour); (b), 793; and (c), 789 (minimum vigour). With Granny Smith, Merton 778 and 793 produced trees of equal size at the same age (Table 5).

The own-rooted Delicious trees were of intermediate size; vigour was conferred on this scion variety by Merton 778, Merton 779 and Essfour rootstocks.

Cropping behaviour.—The yield data from the experimental trees are given in Table 2.

TABLE 2

APPLE ROOTSTOCK TRIAL: CROPPING OF DELICIOUS AT VARIOUS PERIODS

Rootstock	Accumulated Crop, 1958–1961 (lb/tree)	Rootstock	Accumulated Crop, 1958–1965 (lb/tree)	Rootstock	Annual Crop, 1966 (lb/tree)
789	196·1	793	902·0	Essfour ..	186·1
793	184·8	779	896·7	778	181·2
Northern Spy	153·0	778	862·7	779	171·4
Own Roots ..	145·5	789	821·4	Own Roots ..	149·5
778	140·9	Essfour ..	776·5	793	142·8
779	133·2	Own Roots ..	767·2	789	114·7
Essfour ..	96·9	Northern Spy	661·2	Northern Spy	96·4
789 ⩾ Spy ⩾ Own Roots ⩾ 778 ⩾ 779 ⩾ Essfour		793 > Own Roots ⩾ Spy		Essfour > Own Roots ⩾ 793 ⩾ 789 ⩾ Spy	
793 > Spy ⩾ Own Roots ⩾ 778 ⩾ 779 ⩾ Essfour		779 > Own Roots ⩾ Spy		778 > 793 ⩾ 789 ⩾ Spy	
Spy ⩾ Essfour		778 ⩾ Spy		779 ⩾ 789 ⩾ Spy	
Own Roots ⩾ Essfour		789 > Spy		Own Roots > 789 ⩾ Spy	
778 ⩾ Essfour				793 ⩾ Spy	
779 > Essfour					

At 14 years from planting, trees on the Merton series of rootstocks outyielded those on other rootstocks. Merton 789 and 793 rootstocks as well as Northern Spy induced precocity of bearing in the Delicious scion, but even at an early period, trees on these two Merton rootstocks outyielded trees on Northern Spy. By 1965, trees on all four Merton rootstocks had outcropped those on Northern Spy; even the slower cropping, more vigorous on Merton 778 and 779 had then accumulated crops comparable to those recorded from trees on Merton 789 and 793.

As the annual crops from trees on Essfour and Merton 778 are now larger than those from trees on Merton 793 and 789, it is projected that, ultimately, cropping will be proportional to the size of the tree. Comparison between the crop for 1966 and tree girths indicates this trend.

By 1965, trees on Merton 793 and Merton 779 had outyielded all own-rooted Delicious, and these in turn outyielded trees on Northern Spy in 1966. The very vigorous trees on Essfour were tardy in cropping but are now producing the heaviest annual crops.

Tree performance and soil type.—Orchard soils in the Stanthorpe district show considerable variation over relatively small areas. For this reason, a large number of replications were used in this trial to estimate the effect of soil type on the growth and cropping characteristics of trees on a range of experimental rootstocks and also to verify the statement of Hatton (1930) that the relative order of vigour imparted by rootstocks is not changed by soil type.

The growth of the trees as determined by girth measurement on each of these soils is presented in Table 3. The largest trees are on the coarse sandy-clay loam and the smallest are sited on the loamy coarse sand. Trees on the latter soil type also had the smallest girths in 1961.

TABLE 3

APPLE ROOTSTOCK TRIAL: TREE GROWTH ON THREE SOIL TYPES

Girth in cm, 1965

For All Soils		Coarse Sandy Clay Loam		Loamy Coarse Sand		Loamy Coarse Sand Over Coarse Sandy Clay	
Essfour ..	46·85	Essfour ..	51·42	Essfour ..	43·79	Essfour ..	43·55
779	41·30	Own Roots	46·71	779	39·33	779	42·05
778	40·82	778	45·01	778	35·21	778	41·08
Own Roots	40·32	779	42·33	Own Roots	34·10	Own Roots	37·98
793	36·18	793	40·48	793	29·64	793	37·35
789	34·08	789	38·33	789	28·53	789	34·17
Northern Spy	28·99	Northern Spy	33·71	Northern Spy	24·67	Northern Spy	26·95
Essfour⩾779⩾778 ⩾Own Roots⩾793 ⩾789⩾Spy		Essfour⩾Own Roots ⩾778⩾779⩾793 ⩾789⩾Spy		Essfour⩾778⩾Own Roots⩾793⩾789 ⩾Spy		Essfour>Own Roots >793⩾789⩾Spy	
779⩾793⩾789⩾Spy		Own Roots⩾779⩾793 ⩾789⩾Spy		779>Own Roots⩾793 ⩾789⩾Spy		779⩾789⩾Spy	
778⩾793⩾789⩾Spy		778⩾793⩾789⩾Spy		778>793>789⩾Spy		778⩾789⩾Spy	
Own Roots⩾793⩾789 ⩾Spy		779>789⩾Spy		Own Roots>789⩾Spy		Own Roots⩾Spy	
793⩾Spy		793⩾Spy				793⩾Spy	
789⩾Spy		789⩾Spy				789⩾Spy	

The same growth-rootstock relationships were exhibited on all soils, with trees on Essfour maintaining very vigorous growth and those on Northern Spy exhibiting semi-dwarfing characteristics. The own-rooted Delicious trees were relatively large on the sandy-clay loam and this may be associated with their firmer anchorage; seven of the 13 trees on the other two soil types were blown from their upright position in a 1955 gale and had to be reset in their positions.

The relationship between cropping and soil type is less consistent than that between tree growth and soil type as the trees on the different soils do not come into full bearing at the same time. This is illustrated in Table 4. By 1961, the small trees on the loamy coarse sand had yielded more total crop than trees on the sandy-clay loam, but by 1965 the reverse was the case. It should be noted, however, that the large trees on Essfour yielded the largest crop and that the least crop has been borne by the small trees on Northern Spy. From the evidence within Table 2 for annual cropping, the low production from trees on Northern Spy is firmly established.

TABLE 4

APPLE ROOTSTOCK TRIAL: ACCUMULATED CROP (1958–1965)

For All Soils		Coarse Sandy Clay Loam		Loamy Coarse Sand		Loamy Coarse Sand over Coarse Sandy Clay	
Rootstock	lb	Rootstock	lb	Rootstock	lb	Rootstock	lb
793	902·0	793	982·7	779	913·6	779	1,106·3
779	896·7	789	930·1	Essfour ..	817·4	778	1,066·0
778	862·7	Northern Spy	871·7	778	749·3	793	1,036·3
789	821·4	778	815·3	793	683·0	789	935·7
Essfour ..	776·5	Own Roots	783·7	Own Roots	647·3	Essfour ..	916·8
Own Roots	767·2	779	743·8	789	583·6	Own Roots	882·5
Northern Spy	661·2	Essfour ..	651·2	Northern Spy	434·4	Northern Spy	610·0
793 > Own Roots ⩾ Spy		793 > 778 ⩾ Own Roots ⩾ 779 ⩾ Essfour		779 > 793 > Own Roots ⩾ 789 ⩾ Spy		779 ⩾ Spy	
779 > Own Roots ⩾ Spy		789 > Own Roots > 779 ⩾ Essfour		Essfour > 789 ⩾ Spy		778 ⩾ Spy	
778 ⩾ Spy		Spy ⩾ Essfour		778 ⩾ Spy		793 ⩾ Spy	
789 > Spy		778 > Essfour		793 > Spy		789 > Spy	
						Essfour > Spy	
						Own Roots > Spy	

The trees on a loamy coarse sand overlying a coarse sandy clay, although somewhat smaller than those on a sandy-clay loam, outyielded the latter over a period of 15 years.

Mean fruit size and rootstocks.—An estimate of the mean fruit weights has been made, since heavy crops have been produced on the trees. In Table 5 the number of fruits per lb are shown for the years 1963 to 1965; 1965 was a severe drought year.

TABLE 5

ROOTSTOCK TRIAL: MEAN NUMBER OF FRUIT PER LB

Rootstock	1963	1964	1965
Northern Spy	2·35	2·71	5·06
779	2·39	2·63	5·00
778	2·44	2·82	5·66
793	2·50	2·93	5·46
789	2·51	2·85	5·39
Essfour	2·44	2·83	6·52
Own Roots	2·47	2·94	6·09
	789 > Spy	Own Roots > Spy ⩾ 779	Essfour ⩾ 778 ⩾ 793 ⩾ 789 ⩾ Spy ⩾ 779
	793 > Spy	793 > Spy ⩾ 779	Own Roots > 793 > 789 ⩾ Spy ⩾ 779
		789 > 779	778 > Spy > 779
		Essfour > 779	
		778 > 779	

The data indicate that fruit of the largest size are from trees on Northern Spy and Merton 779 for all three years.

Rootstock effects on mean fruit size are not large. They were most conspicuous in the drought year (1965), when the fruit from trees on Northern Spy and Merton 779 maintained their relatively large size while those from trees on Essfour and Own Roots are comparatively small.

Growth and cropping in Granny Smith.—Pertinent data from the Granny Smith guard trees on Merton rootstocks 778 and 793 are given in Table 6.

TABLE 6

APPLE ROOTSTOCK TRIAL: GRANNY SMITH GUARD DATA

Rootstock	Girth, 1965 (cm)	Accumulated Crop, 1958–1965 (lb)	Annual Crop, 1966 (lb)	Mean Weight of 100 Fruit, 1966 (lb)
Merton 778	39·63	991·4	230·0	35·35
Merton 793	36·87	840·7	180·4	35·09
	N.S.	N.S.	778 > 793 (5% level)	N.S.

No significant differences are apparent for tree size, accumulated crop or fruit size up to 1965. So far, the annual crop weight for 1966 is greater for trees on Merton 778 than on 793 and this trend is forecast for Granny Smith.

IV. DISCUSSION

Tydeman (1940) showed in his work with the variety Lane's Prince Albert that the Merton rootstocks are superior to Northern Spy in promoting growth in the scion variety. This is confirmed by the present results with Delicious by Thomas (1945, 1947) for Jonathan, and by Woodhead and McKenzie (1955) for Dougherty. Tydeman's claim that the Merton stocks do not differ markedly from one another in their effect on scion vigour or cropping capacity is at variance with the findings of the above authors and McKenzie (1964) for the variety Jonathan.

The long period of time necessary to evaluate the growth and cropping relationships between a series of rootstocks is well recognized. In the present trial, trees on Merton 793 had cropped more heavily at 10 years of age (1961) than those on Northern Spy, Own Roots, 778, 779 and Essfour. By 1965, however, Merton 793 had outcropped only the trees on Own Roots and Northern Spy.

It is considered legitimate to stress tree size or potential bearing surface of the tree as a useful value for assessing the potential status of a rootstock at any particular time of appraisal. When used in conjunction with the weight of annual crop at the full bearing stage—i.e. when the potential bearing surface is effectively used—a fuller appreciation of the capabilities of a rootstock can be

obtained. In the present trial, it is expected that Delicious trees on Essfour, 778 and 779 will soon outcrop trees on 793 and that there will be no material difference in cropping or tree size between the Merton stocks 778 and 779.

The usefulness and validity of findings from nursery trials as compared to those from orchard trials is a matter of experimental interest. The closely planted nursery trials reported by Thomas (1945) using Jonathan as scion show the same relative order for vigour of rootstock and for accumulated cropping as is reported in the present trial; larger trees and greater crops were produced by Merton 793 than by Merton 789 and least growth and crop were recorded on Northern Spy. The second trial of Thomas (1947) further confirms the finding that trees on Merton 778 and 779 grow larger than those on Northern Spy.

It is suggested that where differences in tree performance are likely to be large, a short-term nursery trial will establish the relative order for growth and cropping, but where differences are of a lesser order, an orchard-scale trial will be necessary to establish significant differences in growth, and particularly in yield, in a closely graded group of rootstocks.

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