

STOCK AND SCION INVESTIGATIONS. XI. A TWENTY-YEAR PRUNING AND ROOTSTOCK TRIAL WITH APPLE TREES

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SUMMARY

Jonathan apple trees on three clonal rootstocks—Malling XII, Essfour and Ivory's Double Vigour—were pruned to three different systems from 1939 to 1959.

Trees with unpruned leaders (Wickens system) grew larger in their early years than trees pruned to other systems. At 20 years of age, trunk girth was still greater than in trees subjected to hard or medium pruning.

Total crop for the 20-year period was greatest in trees pruned to the Wickens system. Confirmatory results were obtained with the variety Granny Smith on Essfour rootstock.

The smallest trees with the least amount of crop were Jonathan and Granny Smith on Ivory's Double Vigour rootstock.

Differences in the weight of crop due to pruning systems could not be correlated with differences in trunk girth.

An index based on crop and trunk growth confirms the merits of trees pruned to the Wickens system. This index showed an increasing value with time.

I. INTRODUCTION

The data presented in this paper are supplementary to those already published (Thomas 1953) which summarized growth and cropping data from an apple rootstock-scion trial at Stanthorpe 11 years from planting in 1939. Tree vigour had declined considerably by 1959, when the orchard was eradicated. By then, however, growth and cropping followed a consistent pattern.

II. MATERIALS AND METHODS

Jonathan trees on three vigorous clonal rootstocks—Malling XII, Essfour, and Ivory's Double Vigour—were trained into vase-shaped trees and subjected to three pruning treatments—(i) Wickens, (ii) medium, and (iii) hard—in their early years of growth.

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In trees pruned to the Wickens system (Wickens 1938, 1939), the leader growth was left unpruned and unpruned lateral shoots were selected to form secondary leaders and increase the framework of the trees. In the medium-pruned trees, two-thirds of the leader growth was removed each year. Laterals under 15 in. long were left unpruned until their second year and then cut back to the first year's growth to promote the formation of fruiting branches. All laterals longer than 15 in. were pruned back to five buds. In the hard-pruned trees, three-quarters of the annual leader growth was pruned away and laterals were shortened to five buds.

Treatments were replicated six times. Each plot comprised six trees with two trees on each of the three rootstocks used.

To ensure adequate cross-pollination for the Jonathan trees, one tree in nine was a Granny Smith on Essfour rootstock; these were pruned to the Wickens system. The external guard trees were Granny Smith planted alternately on Essfour and Ivory's Double Vigour stocks; all were hard-pruned.

Girth measurements at 4 in. above the union were recorded each year as well as yields.

III. RESULTS

Growth in the Variety Jonathan.—The data for tree growth as measured by trunk girth in selected years are presented in Table 1. The trunk girth of Jonathan trees on Ivory's Double Vigour rootstocks was considerably less than on the other two stocks. Trunk girth was apparently not influenced by any of the three systems of pruning applied to the stock-scion combinations under trial. These conclusions confirm those recorded prior to 1948.

TABLE 1

GIRTH DIMENSIONS IN THE VARIETY JONATHAN (CM)

Pruning System	Stocks								
	1948			1954			1959		
	M.XII	Essfour	I.D.V.	M.XII	Essfour	I.D.V.	M.XII	Essfour	I.D.V.
Hard	40.8	39.0	30.9	49.6	47.0	36.0	53.8	50.5	37.4
Medium	40.0	39.9	29.3	47.9	47.7	34.3	50.5	50.9	36.8
Wickens	42.6	41.4	29.8	51.6	49.3	34.9	54.8	52.7	36.5

Cropping in the Variety Jonathan.—Accumulated yields are recorded in Table 2. The total crop was significantly greater on trees pruned to the Wickens system than on trees pruned to other systems up to the year 1954 irrespective of rootstock. The same pattern held on trees worked to Malling XII up to 1959 but was less pronounced on the other two rootstocks. Accumulated yields on

the hard-pruned and medium-pruned trees improved with time, particularly in the case of trees on Ivory's Double Vigour rootstock. There was no significant difference in the cropping records from hard-pruned and medium-pruned trees.

TABLE 2
ACCUMULATED CROPS IN THE VARIETY JONATHAN (LB PER TREE)

Pruning System	Stocks								
	To 1948			To 1954			To 1959		
	M.XII	Essfour	I.D.V.	M.XII	Essfour	I.D.V.	M.XII	Essfour	I.D.V.
Hard	197	153	185	1,182	1,014	735	1,697	1,523	951
Medium	247	211	235	1,127	1,006	770	1,558	1,447	976
Wickens	467	378	320	1,500	1,277	868	1,942	1,736	1,071
Necessary differences for significance (5%)—									
Between hard and medium	74	88	54	220	316	169	311	467	216
Between hard and Wickens or medium and Wickens	71	85	52	212	304	162	300	450	208

Growth in the Variety Granny Smith.—The growth of the Granny Smith trees is summarized in Table 3, where trunk girths are shown for particular years. Granny Smith on Ivory's Double Vigour is obviously a much smaller tree than on Essfour. The early differences in trunk girth between the Wickens and hard-pruning systems applied to trees on Essfour rootstock disappeared by 1959. The final result is therefore similar to that recorded for the variety Jonathan.

TABLE 3
GIRTH (CM) AND CROPPING INDEX IN THE VARIETY GRANNY SMITH

Stock and Pruning System	Girth (cm)			Cropping Index*		
	1948	1954	1959	1948	1954	1959
(a) Essfour—hard-pruned	37.1	46.7	51.2	1.0	4.8	6.6
(b) Essfour—Wickens method	41.8	49.6	51.7	2.8	6.7	8.5
(c) Ivory's Double Vigour—hard-pruned	29.2	33.3	35.4	2.3	7.3	9.2
Necessary differences for significance (5%)—						
Between (a) and (b)	2.5	3.6	4.2	.2	.5	.7
Between (a) and (c)	2.4	3.2	3.7	.3	.6	.8

* Cropping Index is $\frac{\text{Accumulated Crop (lb)}}{\text{Trunk Cross-section (sq. cm.)}}$

Cropping in the Variety Granny Smith.—The average accumulated crop for Granny Smith trees at particular years is given in Table 4. Trees pruned to the Wickens system outyielded trees subjected to hard-pruning and thus responded in the same way as the variety Jonathan. The hard-pruned Granny Smith trees on Ivory's Double Vigour rootstock gave larger crops than similarly pruned trees on Essfour up to 1948. Since that year, the position has been reversed, with heavier yields from trees on Essfour.

TABLE 4
ACCUMULATED CROP IN THE VARIETY GRANNY SMITH (LB PER TREE)

Stock and Pruning System	1948	1954	1959
(a) Essfour—hard-pruned	107	822	1,386
(b) Essfour—Wickens method	397	1,305	1,820
(c) Ivory's Double Vigour—hard-pruned	153	655	934
Necessary differences for significance (5%)—			
Between (a) and (b)	44	153	266
Between (a) and (c)	26	130	224

Trunk Girth and Cropping.—It will be noted from the data presented that, although pruning treatments influence yield, there is no significant correlation between trunk girth and pruning treatment.

To illustrate relationships between growth and cropping in fruit trees, use is often made of a cropping index calculated from the accumulated crop (lb) and the cross-section of the trunk (sq.cm.). A high index value is taken to indicate the efficiency of the tree in terms of fruit production per unit area of trunk wood. The cropping index for Wickens-pruned and hard-pruned trees has been determined for each of three 5-year cropping periods in the varieties Granny Smith (Table 3) and Jonathan (Table 5). The data indicate that for each period trees pruned by the Wickens system have a higher cropping index than the hard-pruned trees irrespective of rootstock.

TABLE 5
CROPPING INDICES FOR THE VARIETY JONATHAN

Stock and Pruning System	M.XII		Essfour		Ivory's Double Vigour	
	Hard	Wickens	Hard	Wickens	Hard	Wickens
1948	1.5	3.2	1.3	2.8	2.4	4.6
1954	6.0	7.1	5.7	6.5	7.0	8.9
1959	7.3	8.1	7.3	7.7	8.4	9.9
Necessary differences for significance (5%)	1948	.4	.3		.4	
	1954	.5	.6		.6	
	1959	.8	.8		.8	

The increasing value of the cropping index with time suggests that crop efficiency improves with age. However, when the rate of cropping over 5-year periods is analysed on a percentage basis (Table 6), it appears that yields actually declined in the 1954–1959 period. This decline would tend to reduce the crop index were it not for the fact the girth increment during the later years of the trial is also low (Table 7).

TABLE 6
PERCENTAGE OF TOTAL CROP FOR 5-YEAR PERIODS IN THE VARIETY JONATHAN

Stock	Pruning System	1944–1948	1948–1954	1954–1959
M.XII	hard-pruned	11.6	58.1	30.3
	Wickens	24.0	53.2	22.8
Essfour	hard-pruned	10.0	56.6	33.4
	Wickens	21.8	51.8	26.4
Ivory's Double Vigour	hard-pruned	19.4	57.8	22.8
	Wickens	29.9	51.1	19.0

TABLE 7
PERCENTAGE GIRTH INCREASE FOR 5-YEAR PERIODS IN THE VARIETY JONATHAN

Stock	Pruning System	1948–1954	1954–1959
M.XII	hard-pruned	21.7	8.5
	Wickens	21.1	6.2
Essfour	hard-pruned	20.7	7.5
	Wickens	19.1	6.9
Ivory's Double Vigour	hard-pruned	16.4	4.0
	Wickens	17.2	4.5

IV. DISCUSSION

Methods of pruning influence the size of the tree and the size of the crop. Chandler (1925, p. 355) listed several apple varieties in which very light pruning increased production over that from trees receiving hard-pruning treatments. He stated that pruning reduces the amount of fruit even though the size of the trees as indicated by trunk girth is not measurably altered.

Recently, Batjer and Westwood (1963) have confirmed that the largest yields come from unpruned trees and that trunk girths are similar in both pruned and unpruned trees.

With the corroborative evidence given in this paper, it appears that trunk girth cannot be correlated with total crop in pruning trials. Thus the measurement of crop is not satisfactorily calculated from trunk girths, but must be measured directly for different treatments. Even a concept such as a "cropping index" derived from cumulative crop weight and trunk growth is of limited value for expressing the interactions between rootstocks, pruning methods and time.

Data from this trial indicate that it is possible to obtain early and high yields with a minimum of pruning to the leaders and laterals, and at the same time produce a large framework capable of bearing heavy crops.

The practice of hard-pruning, on the other hand, reduced cropping in the early years particularly, and also the total of accumulated crop for at least 20 years. Thus there is a clear need for light pruning methods in forming vase-shaped trees or the use of tree forms which do not require continued heavy pruning in their early years of growth.

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