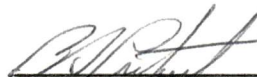


May 1, 1967

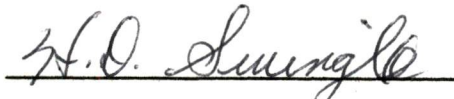
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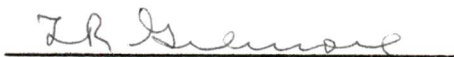
I am submitting herewith a thesis written by Charles A. Mullins entitled "A Study of The Effects of Size-Controlling Rootstocks on Spurring, Blooming, and Fruiting Habits of Two Apple Varieties." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Horticulture.



Major Professor

We have read this thesis and
recommend its acceptance:





Accepted for the Council:



Vice President for
Graduate Studies and Research

A STUDY OF THE EFFECTS OF SIZE-CONTROLLING ROOTSTOCKS ON SPURRING,
BLOOMING AND FRUITING HABITS OF TWO APPLE VARIETIES

A Thesis
Presented to
the Graduate Council of
The University of Tennessee

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
Charles A. Mullins

June 1967

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CHAPTER I

INTRODUCTION

Size-controlling apple rootstocks have been known and used for centuries. At present, there is considerable interest in smaller than standard size trees because they allow almost all orchard operations from pruning to harvesting to be done easier and perhaps with less labor. The smaller trees also present more opportunity for mechanical harvesting.

Some methods besides rootstocks that may be used to dwarf apple trees are as follows: (1) scoring or ringing the trunk, (2) scion variety selection such as spur types, (3) chemicals such as Alar or B-9, (4) severe pruning, (5) low fertility levels, and (6) site selection such as shallow, infertile or sandy soils. Although all these methods have potential, dwarfing by rootstock is most satisfactory at present.

Dwarfing of apple trees offers possible improvement in fruit color and fruit characteristics. Evidence indicates dwarf trees are more open than standard trees. This makes possible more efficient use of sunlight. Therefore, more sugars may be manufactured with better fruit color resulting and more spurs developing. Openness of the tree is probably related to Auxin factors which relates to branch angles.

Apple flowers are usually formed from buds on short shoots known as spurs. Spurs are usually formed from leaf buds on wood in its second

growing season. Spurs usually produce flower buds the year they are formed and every other year thereafter. Fruit set usually occurs with blooming. Annual production is related to numbers of live vigorous spurs on various aged wood throughout the tree and the fruiting of these spurs.

Past studies with dwarfing apple rootstocks have been on tree size, yields and performance of scion varieties with various soils and climates.

The objectives of this investigation were to determine the effects of eight size-controlling rootstocks on leaf bud numbers, and number of spurs developing, blooming, and fruiting on wood of various ages.

CHAPTER II

REVIEW OF LITERATURE

A survey of work conducted in this country revealed little about spurring and fruiting characteristics of apple trees on size-controlling rootstocks. Considerable information is available concerning performance of the various rootstocks in relation to yields and climatic adaptation.

Tukey (5) indicates that an apple variety tends to perform in a certain manner regardless of rootstocks although general characteristics may be altered in degree. Carlson and Tukey (2) state that fruiting habits of different varieties may not be altered by rootstocks but may be speeded up or retarded. They found McIntosh on East Malling (EM) II fruited throughout the tree, both on 1-year-old wood and on fruit spurs of older wood towards the center of the tree. In contrast, Cortland on EM VII fruited terminally on long shoots or spurs as well as on shorter spurs toward the center of the tree. All trees fruited annually rather than biennially. Indications were that trees on EM VII rootstock were more open than those on other rootstocks.

Tukey (5) reports that fewer leaves are necessary on dwarf trees than on standard trees in order to produce a good apple. He indicates that leaf numbers should be 25 per fruit for dwarf trees compared to 35 to 40 for standard size trees. The smaller trees are more open and are therefore more efficient in sugar manufacture.

Kenworthy (4) found that mineral uptake varied between the EM rootstocks. There appeared to be a relationship between tree size and magnesium uptake. Trees on less dwarfing rootstocks absorb more magnesium. Carlson (1) found by leaf analysis that nitrate, phosphate and potash uptake varied between Merton Malling (MM) rootstocks 104, 106, 109 and 111.

Williams (6) has discussed climatic adaptation and variety compatibility for most of the rootstocks used in this experiment.

According to Gourley and Howlett (3) dwarfing rootstocks slow the growth of shoots and spurs. This is associated with early flowering and fruiting. High nitrate and carbohydrate levels are essential for flower and fruit production. Gourley and Howlett (3) state that a large efficient leaf area on both shoots and spurs is essential for heavy flowering and fruiting.

CHAPTER III

MATERIALS AND METHODS

The investigation was conducted at The University of Tennessee Plateau Experiment Station at Crossville, Tennessee. An established orchard of 5-year-old trees on a soil classified as Hartsells fine sandy loam was used. The site had a slight slope with a northern exposure. Experiments conducted in 1965 and 1966 were with two trees of each of the varieties, Red Delicious and Golden Delicious on several rootstocks. The rootstocks used, listed in order of those producing smallest to largest trees are as follows: EM IX interstem (IS), EM VII, MM 106, EM II, MM 104, MM 111, MM 109 and MM 101.

Four branches were selected at random from each tree. Each branch served as a replicate for each observation. For each variety there were 64 replicates and for each rootstock 16 replications for each observation.

One, two and three-year-old wood was marked on each of the four branches in 1965. The new wood grown in 1965 became 1-year-old wood in 1966. The numbers of each character under study occurring per branch were recorded and translated to number per foot of branch. Each year the number of leaf buds per foot was determined for 1-year-old wood. The number of spurs, by age of wood was recorded in March and the blooming spurs in April. Spurs setting fruit and number of

fruits set were counted in May for 2 and 3-year-old wood in 1965 and 1, 2, 3 and 4-year-old wood in 1966. Fruits from wood of all ages were counted in September each year.

Since spurs develop only after the first year's growth, yields of 1-year-old wood were from the terminal bud which often blooms and may fruit.

All data were subjected to analysis of variance according to Snedecor. Relationships between rootstocks, varieties, years and age of wood were determined for each of the factors under study.

Trees were in a vigorous condition throughout the experiment with slight differences in size apparently due to rootstocks. Fruits were produced in 1964 but the first measurable crop was in 1965. The trees were just starting production the year this experiment was initiated. A full crop appeared probable for 1966 but a freeze on May 10 reduced the crop. However, each tree had at least a light crop.

CHAPTER IV

RESULTS AND DISCUSSION

I. LEAF BUDS

Effects of rootstocks on number of leaf buds per foot of 1-year-old wood are shown in Table I. Branches of Red Delicious trees on MM 109 had more leaf buds per foot than those on other rootstocks when the mean of two years is considered. Branches of Golden Delicious trees on EM IX (IS) and EM II had more leaf buds than on other rootstocks. Red Delicious branches on most rootstocks had more leaf buds per foot than Golden Delicious.

II. FRUIT SPURS

No significant differences due to rootstocks were found in number of fruit spurs per foot of 2-year-old wood of Red Delicious (Table II). Golden Delicious trees on EM VII, EM IX (IS) and MM 101 were among those having a greater number of spurs per foot of 2-year-old wood. More spurs were produced on 2-year-old wood during the second year of this experiment which may suggest that as trees age spurs become more numerous on 2-year-old wood. Rootstock MM 111 appeared to be the only one that affected varieties differently in number of spurs produced. More spurs were produced on Red Delicious wood than Golden Delicious on this rootstock.

TABLE I
EFFECTS OF ROOTSTOCKS ON NUMBER OF LEAF BUDS PER FOOT OF ONE
YEAR OLD APPLE WOOD

Rootstock	Number Leaf Buds Per Foot of Wood					
	Red Delicious			Golden Delicious		
	1965	1966	Mean	1965	1966	Mean
EM VII	16.1	14.4	15.2 ¹	13.5	15.5	14.5 ¹
MM 106	19.1	15.1	17.1 ¹	12.6	12.8	12.7 ¹
EM IX (IS)	16.8	15.0	15.9	14.7	18.7	16.7
EM II	19.7	14.4	17.0	17.4	16.1	16.8
MM 104	19.2	15.0	17.1 ¹	15.8	15.0	15.4 ¹
MM 111	18.6	15.8	17.2 ¹	15.7	14.0	14.8 ¹
MM 109	19.6	17.0	18.3 ¹	15.1	13.2	14.4 ¹
MM 101	17.8	15.3	16.6 ¹	14.9	13.6	14.2 ¹
Mean	18.4	15.3	16.8 ¹	15.0	14.9	15.0 ¹
LSD .05 ²	1.3	1.1	0.9	1.3	2.5	0.8

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

²LSD refers to columns directly above it for all tables.

TABLE II
EFFECTS OF ROOTSTOCKS ON NUMBER OF SPURS PER FOOT OF TWO
YEAR OLD APPLE WOOD

Rootstock	Number Spurs Per Foot of Wood					
	Red Delicious			Golden Delicious		
	1965	1966	Mean	1965	1966	Mean
EM VII	8.0	6.3	7.2	8.2	8.3	8.2
MM 106	7.2	8.6	7.9	6.4	8.4	7.4
EM IX (IS)	8.1	6.8	7.4	5.8	11.5	8.6
EM II	6.7	7.9	7.3	6.1	8.5	7.3
MM 104	6.8	8.2	7.5	6.6	8.1	7.4
MM 111	7.5	8.5	8.0 ¹	5.5	7.8	6.6 ¹
MM 109	6.9	7.7	7.3	6.0	6.0	6.0
MM 101	7.0	9.1	8.0	8.1	9.7	8.9
Mean	7.3	7.9	7.6	6.6	8.4	7.5
LSD .05	N. S.	N. S.	N. S.	1.8	N. S.	1.4

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

No significant differences occurred in the mean number of spurs per foot of 3-year-old wood of either variety as shown in Table III. However in 1965, Red Delicious trees on EM IX (IS) were among those producing more spurs per foot of wood. Golden Delicious in 1965 on EM IX (IS) and EM VII had more spurs per foot of 3-year-old wood. These two rootstocks may encourage earlier spurring of trees. No significant differences due to rootstocks were found within varieties on number of spurs produced on 4-year-old wood as shown in Table IV. In general more spurs were produced on Red Delicious than on Golden Delicious.

Spurring of wood does not appear directly related to dwarfing. Trees on MM 101, the least dwarfing rootstock, had almost as many spurs per foot of wood as trees on EM IX (IS), the most dwarfing (Tables II, III and IV).

Fewer spurs were usually present on older wood (Table V). This is due to spurs dying or growing into lateral branches as wood ages.

III. SPURS BLOOMING

No significant differences between rootstocks occurred for Red Delicious with regard to number of spurs blooming per foot of 2-year-old wood as shown in Table VI. The two year mean showed no significant differences occurring with Golden Delicious. Golden Delicious in 1965 produced more blooming spurs on MM 101 and in 1966 on EM IX (IS). Red Delicious branches had more spurs with buds blooming per foot of 3-year-old wood on EM IX (IS) in 1965 (Table VII). Red Delicious on EM IX (IS) was

TABLE III

EFFECTS OF ROOTSTOCKS ON NUMBER OF SPURS PER FOOT OF THREE YEAR OLD
APPLE WOOD

Rootstock	Number Spurs Per Foot of Wood					
	Red Delicious			Golden Delicious		
	1965	1966	Mean	1965	1966	Mean
EM VII	7.3	6.4	6.8	6.7	4.9	5.8
MM 106	6.8	5.7	6.2	5.3	4.6	5.0
EM IX (IS)	8.4	6.6	7.5 ¹	6.6	5.3	6.0 ¹
EM II	7.4	6.0	6.7 ¹	4.9	5.7	5.3 ¹
MM 104	6.9	6.2	6.6 ¹	4.6	6.1	5.4 ¹
MM 111	7.0	7.0	7.0 ¹	5.0	6.0	5.5 ¹
MM 109	7.6	6.9	7.2 ¹	5.0	5.4	5.2 ¹
MM 101	7.0	7.1	7.0	5.4	6.4	5.9
Mean	7.3	6.5	6.9 ¹	5.4	5.5	5.4 ¹
LSD .05	1.1	N. S.	N. S.	1.0	N. S.	N. S.

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

TABLE IV

EFFECTS OF ROOTSTOCKS ON NUMBER OF SPURS BLOOMING PER FOOT OF
FOUR YEAR OLD APPLE WOOD

Rootstock	Number Spurs Per Foot of Wood	
	1966	
	Red Delicious	Golden Delicious
EM VII	5.3	4.9
MM 106	5.1	4.8
EM IX (IS)	6.2	5.6
EM II	6.4 ¹	4.0 ¹
MM 104	5.4 ¹	3.4 ¹
MM 111	6.6 ¹	4.7 ¹
MM 109	7.2 ¹	4.1 ¹
MM 101	6.2 ¹	4.4 ¹
Mean	6.0 ¹	4.5 ¹
LSD .05	N. S.	N. S.

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

TABLE V
EFFECTS OF AGE OF APPLE WOOD ON NUMBER OF SPURS
PER FOOT OF WOOD

	Red Delicious			Golden Delicious		
	2 Year	3 Year	4 Year	2 Year	3 Year	4 Year
1965	7.3x	7.3x	----	6.6x	5.4y	----
1966	7.9x	6.5y	6.0y	8.4x	5.5y	4.5z
Mean	7.6x	6.9y	6.0y	7.5x	5.4y	4.5y

¹Means within a variety not followed by a common letter are significantly different at .05 level.

TABLE VI

EFFECTS OF ROOTSTOCKS ON NUMBER OF SPURS BLOOMING PER FOOT OF TWO
YEAR OLD APPLE WOOD

Rootstock	Number Spurs Blooming Per Foot of Wood					
	Red Delicious			Golden Delicious		
	1965	1966	Mean	1965	1966	Mean
EM VII	5.0	5.5	5.2	2.4	4.0	3.2
MM 106	2.8	7.0	4.9	1.4	4.4	2.9
EM IX (IS)	5.5	4.7	5.1	1.5	9.0	5.2
EM II	5.6	6.4	6.0	2.3	6.2	4.2
MM 104	3.6	5.4	4.5 ¹	3.2	2.8	3.0 ¹
MM 111	4.3	5.3	4.8	3.1	2.3	2.9
MM 109	4.1	5.5	4.8	3.2	1.6	2.4 ¹
MM 101	5.1	5.4	5.2	5.1	3.4	4.3
Mean	4.5	5.6	5.0 ¹	2.8	4.2	3.5 ¹
LSD .05	N. S.	N. S.	N. S.	1.9	2.0	N. S.

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

TABLE VII
EFFECTS OF ROOTSTOCKS ON NUMBER OF SPURS BLOOMING PER
FOOT OF THREE YEAR OLD APPLE WOOD

Rootstock	Number Spurs Blooming Per Foot of Wood					
	Red Delicious			Golden Delicious		
	1965	1966	Mean	1965	1966	Mean
EM VII	3.8	3.9	3.8 ¹	1.2	2.1	1.6 ¹
MM 106	1.7	4.7	3.2	1.4	2.2	1.8
EM IX (IS)	5.5	4.1	4.8 ¹	0.6	3.3	2.0 ¹
EM II	3.1	1.9	2.5	1.3	3.0	2.2
MM 104	2.2	2.9	2.6 ¹	0.7	1.5	1.1 ¹
MM 111	3.2	3.8	3.5	1.0	2.2	1.6
MM 109	2.4	3.0	2.7	0.7	1.3	1.0
MM 101	3.7	3.6	3.6 ¹	1.0	2.5	1.8 ¹
Mean	3.2	3.2	3.2 ¹	1.0	2.3	1.6 ¹
LSD .05	0.7	N. S.	1.4	N. S.	N. S.	N. S.

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

high among a group of stocks in number of spurs blooming per foot of 3-year-old wood, considering the two year mean. No significant differences between rootstocks occurred on 3-year-old Golden Delicious wood.

Table VIII shows that Golden Delicious branches had more spurs per foot of 4-year-old wood on EM IX (IS) but no significant differences existed with Red Delicious. In general more spurs bloomed on Red Delicious branches than on Golden Delicious. Rootstock EM IX (IS) seemed to encourage heavier blooming per foot of wood. As an interstock, EM IX may block translocation at graft unions resulting in more vigorous spurs.

Table IX shows that spurs were more vigorous on younger wood.

IV. SPURS SETTING FRUIT

No significant pattern developed in the number of spurs setting fruit on 2-year-old wood (Table X). Golden Delicious branches on EM II had more spurs setting fruit than on most other stocks in 1966. No significant differences due to rootstock occurred with 3-year-old wood as shown in Table XI. No significant differences occurred with Red Delicious on 4-year-old wood (Table XII). Golden Delicious had more spurs setting fruit per foot of 4-year-old wood on EM IX (IS) than on any rootstock except EM VII.

Trees on EM IX (IS) had fruit set more evenly on wood of all ages. Trees on this stock should require less renewal pruning than trees on other stocks.

TABLE VIII
EFFECTS OF ROOTSTOCKS ON NUMBER OF SPURS BLOOMING PER FOOT OF FOUR
YEAR OLD APPLE WOOD

Rootstock	Number Spurs Blooming Per Foot of Wood	
	1966	
	Red Delicious	Golden Delicious
EM VII	3.0	2.2
MM 106	2.8 ¹	0.9 ¹
EM IX (IS)	3.2	3.8
EM II	3.0	1.9
MM 104	2.9 ¹	0.8 ¹
MM 111	3.2	1.4
MM 109	3.4 ¹	1.2 ¹
MM 101	1.9	2.0
Mean	2.9 ¹	1.8 ¹
LSD .05	N. S.	1.2

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

TABLE IX
EFFECTS OF WOOD AGE ON NUMBER OF SPURS BLOOMING
PER FOOT OF WOOD

	Red Delicious			Golden Delicious		
	2 Year	3 Year	4 Year	2 Year	3 Year	4 Year
1965	4.5x	3.2y	---	2.8x	1.0y	
1966	5.6x	3.2y	2.9y	4.2x	2.3y	1.8y
Mean	5.0x	3.2y	2.9y	3.5x	1.6y	1.8y

¹Means within a variety not followed by a common letter are significantly different at .05 level.

TABLE X

EFFECTS OF ROOTSTOCKS ON NUMBER OF SPURS SETTING FRUIT
PER FOOT OF TWO YEAR OLD APPLE WOOD

Rootstocks	Number Spurs Setting Fruit Per Foot of Wood					
	Red Delicious			Golden Deliciou		
	1965	1966	Mean ¹	1965	1966	Mean ¹
EM VII	1.9	0.4	1.2	2.0	2.2	2.1
MM 106	1.7	0.8	1.2	1.0	1.9	1.4
EM IX (IS)	1.7	0.2	1.0	1.5	1.9	1.7
EM II	3.4	0.5	2.0	2.2	2.8	2.5
MM 104	1.8	0.3	1.0	1.1	1.2	1.2
MM 111	1.9	0.4	1.2	2.2	1.1	1.6
MM 109	1.8	0.4	1.1	1.3	0.2	0.8
MM 101	2.0	0.1	1.0	2.2	0.1	1.2
Mean	2.0	0.4	1.2	1.7	1.4	1.6
LSD .05	N. S.	N. S.	N. S.	N. S.	1.6	N. S.

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

TABLE XI

EFFECTS OF ROOTSTOCKS ON NUMBER OF SPURS SETTING FRUIT PER FOOT
OF THREE YEAR OLD APPLE WOOD

Rootstocks	Number Spurs Setting Fruit Per Foot of Wood					
	Red Delicious			Golden Delicious		
	1965	1966	Mean ¹	1965	1966	Mean ¹
EM VII	0.8	0.4	0.6	0.6	0.5	0.6
MM 106	0.6	0	0.3	1.4	0.9	1.2
EM IX (IS)	1.2	0.4	0.8	0.5	0.8	0.6
EM II	1.9	0.1	1.0	0.5	1.4	2.0
MM 104	1.0	0.1	0.6	0	0.2	0.1
MM 111	1.2	0.1	0.6	0.3	0.7	0.5
MM 109	0.7	0.3	0.5	0.3	0.3	0.3
MM 101	1.0	0	0.5	0.2	0.6	0.4
Mean	1.1	0.2	0.6	0.5	0.7	0.6
LSD .05	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.

¹No significant differences between variety means at .05 level.

TABLE XII
EFFECTS OF ROOTSTOCKS ON NUMBER OF SPURS SETTING FRUIT PER
FOOT OF FOUR YEAR OLD APPLE WOOD

Rootstocks	Number Spurs Setting Fruit Per Foot of Wood 1966	
	Red Delicious	Golden Delicious
EM VII	0.1 ¹	1.0 ¹
MM 106	0	0.2
EM IX (IS)	0.1 ¹	1.4 ¹
EM II	0.2 ¹	0.6 ¹
MM 104	0	0.1
MM 111	0	0.7
MM 109	0	0
MM 101	0	0
Mean	0.1 ¹	0.5 ¹
LSD .05	N. S.	0.6

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

Table XIII, page 23, shows that more fruit is set on younger spurs than older spurs in most cases.

V. FRUIT SET

The number of fruit set were recorded and analyzed along with the number of spurs setting fruit. Results were like those for spurs setting fruit.

VI. YIELDS

Red Delicious on EM IX (IS) produced more fruit per foot of 1-year-old wood in 1965 (Table XIV). No fruits were produced on 1-year-old Red Delicious wood in 1966. Golden Delicious trees on EM IX (IS) had more fruit harvested per foot of 1-year-old wood in 1966. It can be seen from the mean for the two year test that Golden Delicious on EM IX (IS) fruited well.

No significant differences due to rootstocks were noted for yields of 2-year-old Red Delicious wood (Table XV). Golden Delicious trees on EM VII and EM II had the highest yields per foot of wood for both years.

Red Delicious trees on MM 111, EM II and EM IX (IS) were among the highest in yield per foot of 3-year-old wood (Table XVI) in 1965. Golden Delicious trees on MM 106 in 1965 had more yield per foot of 3-year-old wood. It would appear from the table that perhaps additional data might resolve some of the apparent confusion. In 1966, Golden Delicious on EM IX (IS) and EM II would appear to approach the yield

TABLE XIII
EFFECTS OF AGE OF APPLE WOOD ON NUMBER OF SPURS SETTING
FRUIT PER FOOT OF WOOD

	Red Delicious			Golden Delicious		
	2 Year	3 Year	4 Year	2 Year	3 Year	4 Year
1965	2.0x	1.1y	---	1.7x	0.5y	
1966	0.4x	0.2x	0.1x	1.4x	0.7y	0.5y
Mean	1.2x	0.6y	0.1y	1.6x	0.6y	0.5y

¹Means within a variety not followed by a common letter are significantly different at .05 level.

TABLE XIV

EFFECTS OF ROOTSTOCKS ON YIELD PER FOOT OF ONE YEAR OLD APPLE WOOD

Rootstock	Number Fruit Harvested Per Foot of Wood					
	Red Delicious			Golden Delicious		
	1965	1966	Mean [†]	1965	1966	Mean [†]
EM VII	0.1	0	0.1	0.9	0	0.4
MM 106	0.1	0	0.1	1.3	0	0.6
EM IX (IS)	1.0	0	0.5	1.5	2.4	4.0
EM II	0	0	0	0.6	0.2	0.4
MM 104	0.1	0	0.1	0.1	0.2	0.2
MM 111	0	0	0	0	0.2	0.1
MM 109	0.1	0	0.1	0.2	0	0.1
MM 101	0.2	0	0.1	0.3	0	0.2
Mean	0.2	0	0.1	0.6	0.4	0.5
LSD .05	0.6	N. S.	N. S.	N. S.	1.4	1.1

[†]No significant differences between variety means, at .05 level.

TABLE XV

EFFECTS OF ROOTSTOCKS ON YIELD PER FOOT OF TWO YEAR OLD APPLE WOOD

Rootstock	Number Fruit Harvested Per Foot of Wood					
	Red Delicious			Golden Delicious		
	1965	1966	Mean	1965	1966	Mean
EM VII	0.7	0.4	0.6 ¹	1.7	2.3	2.0 ¹
MM 106	0.3	0.3	0.3	1.1	1.7	1.4
EM IX (IS)	0.4	0.1	0.2	0.2	1.2	0.7
EM II	0.7	0.2	0.4 ¹	0.9	2.5	1.7 ¹
MM 104	0.7	0.1	0.4 ¹	0.7	1.2	1.0 ¹
MM 111	0.6	0.1	0.4	0.4	0.7	0.6
MM 109	0.5	0.3	0.4	0.5	0.2	0.4
MM 101	1.2	0	0.6	0.6	0	0.3
Mean	0.6	0.2	0.4 ¹	0.8	1.2	1.0 ¹
LSD .05	N. S.	N. S.	N. S.	0.8	1.5	1.0

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

TABLE XVI
EFFECTS OF ROOTSTOCKS ON YIELD PER FOOT OF THREE YEAR
OLD APPLE WOOD

Rootstock	Number Fruit Harvested Per Foot of Wood					
	Red Delicious			Golden Delicious		
	1965	1966	Mean	1965	1966	Mean
EM VII	0.4	0.2	0.3	0.6	0.6	0.6
MM 106	0.1	0	0.1 ¹	1.7	0.7	1.2 ¹
EM IX (IS)	0.8	0.3	0.6	0.3	1.0	0.6
EM II	0.9	0.1	0.5	0.3	1.4	0.8
MM 104	0.6	0.1	0.4	0	0.2	0.1
MM 111	1.1	0.1	0.6	0.2	0.6	0.4
MM 109	0	0.2	0.1	0.3	0.4	0.4
MM 101	0.6	0	0.3	0.1	0.4	0.2
Mean	0.6	0.1	0.4	0.4	0.7	0.6
LSD .05	0.5	N. S.	0.4	0.7	N. S.	0.6

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

suggested for Red Delicious on these rootstocks.

Table XVII shows that no significant differences occurred in yields of 4-year-old wood on various rootstocks. Golden Delicious trees produced more fruit per foot of wood on EM IX (IS) than on other rootstocks except EM II. These were the only two rootstocks on which Red Delicious wood produced fruit.

Golden Delicious trees yielded more fruit per foot of wood than Red Delicious even though Red Delicious wood usually had more spurs and more spurs blooming. Spring freeze damage during the two years was apparently more injurious to Red Delicious since buds on this variety swelled and blooms opened earlier. The buds of both varieties were severely injured by a freeze on May 10, 1966.

In general more fruits were harvested per foot of 2-year-old wood followed in order by 3, 4, and 1-year-old wood (Table XVIII).

TABLE XVII
EFFECTS OF ROOTSTOCKS ON YIELD PER FOOT OF FOUR YEAR OLD APPLE WOOD

Rootstock	Number Fruit Harvested Per Foot of Wood 1966	
	Red Delicious	Golden Delicious
EM VII	0 ¹	1.0 ¹
MM 106	0	0.3
EM IX (IS)	0.2 ¹	1.7 ¹
EM II	0.1 ¹	0.6 ¹
MM 104	0	0.1
MM 111	0	0.7
MM 109	0	0
MM 101	0	0
Mean	0	0.6
LSD .05	N. S.	0.8 .

¹Indicates significant differences (.05 level) between the means of Red Delicious and Golden Delicious.

TABLE XVIII
EFFECTS OF AGE OF WOOD ON YIELDS PER FOOT OF WOOD

	Red Delicious ¹				Golden Delicious ¹			
	1 Year	2 Year	3 Year	4 Year	1 Year	2 Year	3 Year	4 Year
1965	0.2x	0.6y	0.6y	---	0.6x	0.8x	0.4x	---
1966	0x	0.2y	0.1z	0x	0.4x	1.2y	0.7x	0.6x
Mean	0.1x	0.4y	0.4y	0x	0.5x	1.0y	0.6x	0.6x

¹Means within a variety not followed by a common letter are significantly different at .05 level.

CHAPTER V

SUMMARY AND CONCLUSIONS

Two apple varieties on eight size controlling rootstocks were compared for number of leaf buds, spurs, spurs blooming, spurs setting fruit, fruit set and yield per foot of various aged wood over a two-year period.

Red Delicious on MM 109 and Golden Delicious on EM IX (IS) and EM II had more leaf buds per foot of 1-year-old wood.

Rootstocks did not appear to differ in their influence on number of spurs produced per foot of wood. In general more spurs were present on 2-year-old wood than older wood.

Branches of trees on EM IX (IS) usually had more spurs producing blooms than those on other rootstocks.

Rootstocks did not appear to differ in influencing number of spurs setting fruit.

Although not always statistically significant at the .05 level, both varieties on EM IX (IS) usually yielded more fruit per foot of wood followed by those on EM VII, EM II and MM 106. Trees on EM IX (IS) are about one-half the size of standard trees. Trees on EM II are two-thirds standard size. The smaller trees in general had more yield per foot of wood. Since the smaller trees are planted closer, higher yields per acre should be obtained earlier and throughout the life of trees on

EM IX (IS) rootstock unless factors not observed in this set of experiments should begin to play some part in the production pattern.

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