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The influence of heading back on bud performance of one year-old apple shoots

Douglas D. Baird

To the Graduate Council:

I am submitting herewith a thesis written by Douglas D. Baird entitled "The influence of heading back on bud performance of one year-old apple shoots." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Landscape Architecture.

B.S. Pickett, Major Professor

We have read this thesis and recommend its acceptance:

Joe S. Alexander, Roger B. Thompson, Gordon E. Hunt

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

March 27, 1963

To the Graduate Council:

I am submitting herewith a thesis written by Douglas D. Baird entitled "The Influence of Heading Back on Bud Performance of One Year-Old Apple Shoots." 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:

Joe S. Alexander

Roger B. Thompson

Accepted for the Council:

Dean of the Graduate School

THE INFLUENCE OF HEADING BACK ON BUD PERFORMANCE OF ONE YEAR-OLD APPLE SHOOTS

A Thesis

Submitted to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Douglas D. Baird

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D. D. B.

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CHAPTER I

INTRODUCTION

Pruning is one of the oldest and most universally practiced orchard operations. (1) The fundamental objectives of pruning are to improve the quality and quantity of fruit and to lower the cost of production. There is no horticultural practice on which there is greater diversity of opinion or application of procedure. (7) The average grower, when asked why he does or does not prune, generally will reply that it is good or not good for the tree. (7) Some of the specific objectives assigned to pruning are (1) to open the tree for more fruit color, (2) train to a desired form, (3) remove dead and diseased parts, (4) remove water sprouts and cross-branches and (5) to thin fruit. (7)

Pruning may vary in three respects; (1) the amount of wood removed, or severity, (2) the kind or position and (3) the season. There are two methods of pruning: "thinning out" and "heading back." "Thinning out" is a method that removes whole shoots or branches. "Heading back" removes a portion of a shoot.

The lateral buds of most species of plants are formed in the axil of each leaf. They seldom grow immediately, but tend to remain dormant during the season in which they are formed. Failure of the newly formed lateral buds to grow immediately is commonly attributed to "apical dominance." If the terminal bud is removed, one or more of the lateral buds may begin to grow. Inhibition of the lateral buds by the terminal bud seems to be a polar phenomenon influenced by gravity. It has been

shown, using indoleacetic acid on the cut surface following removal of the terminal bud, that the lateral buds remain quiescent as if the terminal bud were present. This suggests that an auxin might be produced by the terminal bud or in the region of the terminal bud. It is interesting to speculate on the reasons why the terminal bud, which is considered as the site of auxin production, continues to grow actively when buds behind it are inhibited.

Apple flowers are usually borne terminally on short shoots known as spurs. Occasionally flowers are borne terminally on shoots. Some varieties produce flowers rather commonly in this fashion. Individual spurs seldom bear annually, although the spurs of some varieties are more likely to do so than others. Heavy annual production depends on the formation of numerous new spurs and the maintenance of old spurs in a vigorous condition. Spurs are usually produced from lateral buds of the preceding season's growth, rarely on old wood from either latent or adventitious buds.

Previous studies have been done to determine the effect of severity of pruning on trees as a whole, but not on the effect of bud performance on shoots.

The objectives of this investigation were to determine the effect of heading back one-year-old wood on the establishment of the spur system, the production of new shoots, and the forcing of buds which are expected to remain dormant or latent.

CHAPTER II

REVIEW OF LITERATURE

A search of the literature written in this country revealed little information from well-planned experimental work on pruning of the mature apple. Results secured from experiments in widely separated parts of the country are not always compatible. The literature does not produce evidence on the effects of heading back shoots of different lengths on bud performance.

Heavy pruning has been considered a stimulant to vegetative growth. Usually such pruning is considered to delay fruiting of young trees, and to reduce production of older trees. Some of the literature suggests that pruning in any amount is restrictive because it checks growth. (2) Bedford and Pickering (2) showed that the unpruned tree increases in size and weight more rapidly than the pruned tree and that the heavier the pruning the more pronounced is the check upon growth. "Since the general influence of pruning is to check increases in size, it might be reasoned that it results in a corresponding decrease in the amount of new shoot growth produced each year." (8)

Heading back is said to have a more stimulating influence, and the pruned shoots tend to give rise to as much, or more, new shoot growth as would have arisen from the unpruned tree. (9) "Heading back removes a larger amount of the tree reserves than a corresponding severe thinning out and leaves the tree less able to recuperate, especially if the pruning has been severe." Heading back induces a disturbance of an equilibrium

within the branch itself. Each branch, as it grows, may be regarded as a system in equilibrium, comparable to that in the plant as a whole. If a portion of the branch is removed, this balance is disturbed. Equilibrium is re-established by regeneration at the point of removal. (10)

In contrast to thinning out, heading back generally tends not only to reduce the number of spurs, but also to lower the percentage that differentiate into fruit buds. (9) The development of a more extensive fruiting system, and the more efficient functioning of that system, are favored more by thinning out than by heading back. (10) Maximum fruit spur formation is encouraged by leaving the trees unpruned, or by pruning them very lightly. (11)

To determine the effect of winter heading back of one-year-old shoots on subsequent development of spurs and branch shoots, Gardner (12) worked with four varieties in Oregon and his conclusions were:

> In general, heading the individual dormant apple shoot decreases the number of new branch shoots to which it gave rise, this decrease in number of new shoots being greater with increase in severity of heading. . .
>
> Broadly speaking, a general heading-back of the shoots of a tree acted as a stimulus to new shoot growth resulting in an increase in number of units of new shoot-growth for each unit of old, as compared with unpruned trees. The amount of this stimulus varied considerably with variety.
>
> In Grimes, heading-back, within the range employed (i.e., 0-80%), exerted comparatively little influence upon the amount of new shoot growth to which the individual shoot gave rise. In other words, the amount of new shoot growth to which a shoot will give rise the following year is correlated with the length before pruning rather than with its length after pruning or with the amount or severity of the pruning it may receive. There is reason to believe that in some varieties, it acts as a stimulus to shoot growth. Heading-back generally led to an increased production of fruit buds terminally upon shoots. (12)

Bedford and Pickering (2) found that with an increasing amount of wood removed (to 17 per cent of the original length) from one-year-old shoots that there was a decrease in the number of shoots developing and also a decrease in the total length and weight of the shoots produced. However, when the older wood immediately in back of the treated shoots was considered (two-year-old wood), Bedford and Pickering (2) found that by increasing the severity of pruning on the one-year-old shoot, more shoots developed from the older portions of the branch. The number of blossom buds followed the same trend on the one-year-old wood.

Bedford and Pickering summarized their findings by stating:

> From every point of view, therefore, it would appear that pruning is disadvantageous to a fruit tree, and the more it can be reduced, the better. But this does not by any means imply that it ought to be dispensed with. (6)

> Pruning should be reduced so far as is consistent with the formation of a well-shaped tree, capable of carrying such a crop as it is likely to produce. The pruning will, of course, retard the development of the tree, but the extension of the branches is arrested more than the filling out of the branches, and hence a more compact and sturdier tree will be produced. (4)

> That pruning encourages growth, is, except under certain special conditions, one of the fallacies prevalent in horticulture. (3)

Culliman, (6) working in Indiana, stated that heading back during the first three years had reduced root growth by 41 per cent. Chandler (5) states that pruning of any kind reduces root growth generally. Heading back of Golden Delicious shoots which were less than six to eight inches resulted in increased vigor and more growth. (13)

Contrasting statements have been made by the leading authorities on heading back of the apple as a stimulus to shoot growth. Bedford and

Pickering (2) have stated that by increasing the severity of heading back, the number of new shoots arising from the one-year-old wood decreases. Gardner (12) states that generally this is the case, but in broad terms an overall heading back stimulates shoot production per unit. Gardner (12) also believes that there is a varietal difference to a heading back stimulus. On Grimes, Gardner (12) contended that the length of the one-year-old shoot before heading back determined the amount of new shoot growth rather than the severity or length after pruning. There seems to be a general concensus of opinion that any form of heading back reduces the total number of spurs.

CHAPTER III

METHODS AND MATERIALS

The investigation was performed on Cherokee Farm, of The University of Tennessee, at Knoxville, Tennessee. An established orchard of five-year-old trees on a soil classified as Cumberland silty clay loam, eroded hilly phase, with an eastern slope of 18 per cent was used. The experiment was initiated during the late winter of 1959 on two varieties, Lodi and Cortland. In the following two years, Jonathan and Early McIntosh varieties were added to the study. These latter two varieties were of the same age as the Lodi and Cortland. Twenty trees of Lodi, Cortland and Jonathan, and fifteen trees of Early McIntosh were selected. Data were recorded on the response of 10 one-year-old vigorous shoots on each tree each year. Five were less and five were more than 10 inches in length, making a total of 100 of each length on each variety. The following chart lists the treatment and the treatment symbol which will be used throughout the discussion in explaining the results.

TREATMENT	SYMBOL
1. No pruning	NP
2. Terminal bud removed	TR
3. 1/4 of the shoot removed	1/4 R
4. 1/2 of the shoot removed	1/2 R
5. 3/4 of the shoot removed	3/4 R

Shoots under ten inches were treated like those over ten inches. The two different shoot lengths were differentiated by different paint colors each year. Every year shoots were selected from branches that had

not been previously treated, and the selections were all made on the southwest side in the lower middle portion of the tree.

The data were recorded each September. The number and position of the buds developing into shoots, spurs, or remaining latent on each shoot were recorded. The bud at the base of the shoot was considered the first bud.

During the three year period, fireblight infestation (Erwinia amylovora) was moderate to heavy, affecting Lodi and Jonathan trees most severely. Shoots infected during the season were discarded.

The data were subjected to analysis of variance as described by Snedcor. Relationships between the number of buds developing into shoots, spurs or remaining dormant within treatments, between treatments, within varieties, between varieties and the orchard as a whole were determined.

The test period began March 1959 and ended September 1961. The trees were five years old at the beginning of the study, and were considered adolescent. The first year, they produced no fruits. The second (1960) Lodi and Cortland produced some fruit, and the third year all varieties were fruiting.

CHAPTER IV

RESULTS AND DISCUSSION

I. VARIETY BUD RESPONSE

Bud performance on Lodi shoots longer and shorter than ten inches in length is shown in Table I.

When long Lodi shoots were not pruned or had only the terminal removed, a greater number of buds developed into spurs than remained dormant and, in turn, a greater number of buds remained dormant than developed into shoots. However, when one-half to three-fourths of the shoot was removed, about the same number of buds remained dormant or developed into shoots, and each of these was more than developed into spurs.

When short Lodi shoots were not pruned or had the terminal removed, a greater number of buds remained dormant than developed into spurs and the number developing into spurs were greater than those developing into shoots. When one-half to three-fourths of the shoot was removed, about the same number of buds remained dormant or developed into shoots, and each was more than developed into spurs.

Bud performance on Cortland shoots longer and shorter than ten inches in length is shown in Table II.

When unpruned, or the terminal bud, or one-fourth of the long Cortland shoots were removed, more buds remained dormant than developed into spurs or shoots, and the number that developed into spurs and shoots

TABLE I

RESPONSE TO TREATMENTS DURING EACH YEAR ON LODI SHOOTS
LONGER THAN AND SHORTER THAN TEN INCHES

Shoot Length Over Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Shoots	2.44	2.65	3.25	3.47	2.95	3.40	3.26	2.85	2.80	2.35	2.50	2.15	2.05	2.05	1.80
Spurs	8.22	7.85	8.00	6.05	8.20	6.40	3.74	6.25	4.35	1.55	2.45	1.60	.68	.50	.40
Dormant	5.00	6.50	4.30	5.26	4.95	2.80	2.47	5.20	3.45	3.00	2.70	2.90	1.32	2.50	2.20
LSD 1%	2.61	2.04	1.93	2.04	1.58	1.69	NS	1.46	1.40	1.03	NS	.81	.57	.74	.55
LSD 5%	1.94	1.51	1.43	1.51	1.17	1.25	NS	1.08	1.04	.76	NS	.60	.42	.55	.41

Shoot Length Under Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Shoots	1.05	1.05	1.26	1.68	1.56	1.40	1.35	1.25	1.45	1.10	1.50	1.20	1.15	1.05	.95
Spurs	1.70	3.20	3.21	2.36	2.72	2.60	1.85	1.40	1.15	.85	.50	.75	.30	.40	.35
Dormant	3.85	3.25	4.58	3.74	2.88	3.70	2.75	2.55	3.40	1.85	1.72	2.40	1.40	1.15	1.70
LSD 1%	1.25	1.20	1.28	.79	.81	.95	.82	.55	.73	.74	.46	1.55	.63	.40	.40
LSD 5%	.93	.89	.95	.58	.60	.70	.61	.41	.54	.55	.34	1.15	.47	.29	.30

TABLE II

RESPONSE TO TREATMENTS DURING EACH YEAR ON CORTLAND SHOOTS
LONGER THAN AND SHORTER THAN TEN INCHES

Shoot Length Over Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Shoots	4.00	2.60	4.00	3.75	4.40	3.26	3.05	3.80	2.37	2.80	2.85	2.00	1.65	2.16	1.78
Spurs	3.05	4.00	3.94	2.50	5.60	3.05	2.11	3.35	2.16	1.20	2.10	1.32	.75	.53	.89
Dormant	7.30	10.47	6.94	6.35	6.40	6.26	5.00	4.75	5.58	2.20	2.90	3.37	1.80	2.63	1.94
LSD 1%	1.22	2.20	1.60	1.30	1.95	1.37	1.16	NS	1.23	1.07	NS	.84	.64	.68	.57
LSD 5%	.91	1.63	1.19	.96	1.45	1.02	.84	1.15	.91	.79	.68	.60	.47	.51	.42

Shoot Length Under Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Shoots	1.05	1.05	1.21	1.05	.90	1.28	.70	.78	.90	.35	.47	.90	.16	.35	1.00
Spurs	.95	.95	.90	2.05	1.58	.50	1.90	1.39	.68	1.70	1.32	.37	1.21	.77	.11
Dormant	5.37	6.05	6.84	4.25	4.47	5.78	3.30	3.39	4.16	1.95	2.58	2.95	1.53	1.71	1.89
LSD 1%	1.02	1.08	.88	1.02	.81	.56	.86	.68	.68	.75	.51	.53	.51	.43	.29
LSD 5%	.76	.80	.65	.76	.60	.41	.64	.50	.51	.56	.38	.39	.38	.32	.22

was about the same. When one-half and three-fourths of the shoot was removed about the same number remained latent or developed into shoots, and these were more than developed into spurs.

Short Cortland shoots had the same response as the long shoots.

The bud performance on Jonathan shoots longer and shorter than ten inches in length is shown in Table III.

When long Jonathan shoots were not pruned or had the terminal or one-fourth of the shoot removed, a greater number of buds developed into spurs than remained dormant, while more buds remained dormant than developed shoots. When one-half of the shoot was removed, about the same number of buds developed shoot, spurs or remained latent. A greater number remained dormant than developed shoots and, in turn, more developed shoots than spurs when three-fourths of the shoot was removed.

On short Jonathan shoots, when pruned back to one-fourth of the shoot length, more buds remained dormant than developed spurs and likewise more spurs developed than shoots. When one-half or three-fourths of the shoot was removed, more buds remained dormant than developed into shoots, which in turn were more than developed into spurs.

The bud response on Early McIntosh shoots longer and shorter than ten inches in length is shown in Table IV.

Long Early McIntosh shoots responded like the long Jonathan shoots when unpruned or the terminal or one-fourth of the shoot was removed. That is, there were more spurs developing than buds remaining dormant and, in turn, more dormant buds than shoots. When one-half or three-fourths of the shoots was removed more buds remained dormant than developed shoots and more shoots developed than spurs.

TABLE III

RESPONSE TO TREATMENTS DURING EACH YEAR ON JONATHAN SHOOTS
LONGER THAN AND SHORTER THAN TEN INCHES

Shoot Length Over Ten Inches

Treatment	NP		TR		1/4 R		1/2 R		3/4 R	
Year	1960	1961	1960	1961	1960	1961	1960	1961	1960	1961
Shoots	3.00	3.00	2.94	3.06	2.58	2.61	2.89	2.41	1.82	1.82
Spurs	8.61	9.44	7.77	7.72	6.21	6.22	2.32	2.18	.35	.65
Dormant	6.50	6.44	5.00	6.55	3.95	4.89	3.26	2.29	2.94	2.24
LSD 1%	2.40	2.34	2.05	2.52	1.64	.71	NS	NS	.71	.68
LSD 5%	1.80	1.73	1.52	1.87	1.21	.52	.85	NS	.52	.50

Shoot Length Under Ten Inches

Treatment	NP		TR		1/4 R		1/2 R		3/4 R	
Year	1960	1961	1960	1961	1960	1961	1960	1961	1960	1961
Shoots	1.42	1.19	1.67	1.40	1.42	1.17	1.50	.94	1.00	.77
Spurs	2.58	3.81	2.67	2.87	1.74	2.00	.61	.35	.23	.12
Dormant	4.90	4.00	4.33	3.13	3.58	3.06	3.00	3.12	2.23	2.12
LSD 1%	1.21	1.34	1.07	1.10	.88	.78	.56	.56	.54	.41
LSD 5%	.90	1.00	.80	.82	.65	.58	.41	.41	.40	.30

TABLE IV

RESPONSE TO TREATMENTS DURING EACH YEAR ON EARLY MCINTOSH
SHOOTS LONGER THAN AND SHORTER THAN TEN INCHES

Shoot Length Over Ten Inches

Treatment	NP		TR		1/4 R		1/2 R		3/4 R	
Year	1960	1961	1960	1961	1960	1961	1960	1961	1960	1961
Shoots	1.67	2.53	1.60	2.20	2.07	2.53	2.27	2.20	1.69	1.47
Spurs	9.20	8.20	7.40	6.07	5.60	4.53	2.33	1.33	1.00	.53
Dormant	6.73	3.33	6.00	4.20	4.40	3.40	3.40	3.13	1.77	2.33
LSD 1%	2.32	1.48	2.39	1.50	1.59	1.13	NS	.74	.70	.60
LSD 5%	1.72	1.09	1.78	1.11	1.18	.84	.86	.55	.52	.45

Shoot Length Under Ten Inches

Treatment	NP		TR		1/4 R		1/2 R		3/4 R	
Year	1960	1961	1960	1961	1960	1961	1960	1961	1960	1961
Shoots	.53	.93	.40	1.14	.47	1.00	.60	1.21	.27	.71
Spurs	4.20	3.50	3.80	3.14	2.67	2.21	1.13	.57	.93	.43
Dormant	4.20	4.57	4.13	3.21	3.33	2.71	2.60	2.57	1.67	1.86
LSD 1%	1.87	1.85	1.15	1.16	.79	.69	.77	.55	.56	.48
LSD 5%	1.40	1.37	.86	.86	.79	.51	.57	.41	.41	.35

There were about the same number of buds remaining dormant as developed spurs and each of these was more than developed shoots on short Early McIntosh shoots when up to one-fourth of the shoot was removed. When one-half and three-fourths of the shoot was removed, the bud response was like that of the same treatments on long Early McIntosh shoots.

The conclusion may be drawn that, even considering varietal differences, the bud performance on long or short shoots does not change in proportional numbers until one-quarter or one-half of the shoot length has been removed. In all cases with this amount of pruning the buds remaining dormant predominated.

II. COMPARISON OF VARIETAL BUDS DEVELOPING INTO SHOOTS, SPURS AND REMAINING DORMANT

The response between varieties in number of buds per shoot developing into shoots within each treatment is shown in Table V.

When long shoots were not pruned or had one-half or three-fourths of the shoot removed about the same number of buds developed into shoots on all four varieties. However, when the terminal or one-fourth of the shoot was removed, Cortland produced more shoots than Early McIntosh and there was not significant difference between this variety and Lodi or Jonathan.

With an increase in the amount of heading back on short shoots, Jonathan and Lodi had about the same number of shoots developing and these were more than developed on Cortland or Early McIntosh.

The response between varieties in the number of buds per shoot developing into spurs within each treatment is shown in Table VI.

TABLE V

COMPARISON OF VARIETIES AS TO BUDS DEVELOPING INTO SHOOTS WITHIN EACH TREATMENT

Shoot Length Over Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Lodi	2.44	2.65	3.25	3.47	2.95	3.40	3.26	2.85	2.80	2.35	2.50	2.15	2.05	2.05	1.80
Cort.	4.00	2.60	4.00	3.75	4.40	3.26	3.05	3.80	2.37	2.80	2.85	2.00	1.65	2.16	1.78
Jona.	--	3.00	3.00	--	2.94	3.06	--	2.58	2.61	--	2.90	2.41	--	1.82	1.82
E. Mc.	--	1.67	2.53	--	1.60	2.20	--	2.07	2.53	--	2.27	2.20	--	1.69	1.47
LSD 1%	NS	NS	NS	NS	2.11	NS	NS	1.69	NS	NS	NS	NS	NS	NS	NS
LSD 5%	1.48	NS	1.51	NS	1.56	NS	NS	1.35	NS	NS	NS	NS	NS	NS	NS

Shoot Length Under Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Lodi	1.05	1.05	1.26	1.68	1.56	1.40	1.35	1.25	1.45	1.10	1.50	1.20	1.15	1.05	.95
Cort.	1.05	1.05	1.21	1.05	.90	1.28	.70	.78	.90	.35	.47	.90	.16	.35	1.00
Jona.	--	1.42	1.19	--	1.67	1.40	--	1.42	1.17	--	1.50	.94	--	1.00	.77
E. Mc.	--	.53	.93	--	.40	1.14	--	.47	1.00	--	.60	1.21	--	.27	.71
LSD 1%	NS	NS	NS	NS	1.01	NS	NS	.79	NS	.74	.60	NS	.57	.51	NS
LSD 5%	NS	NS	NS	NS	.75	NS	.61	.58	NS	.54	.45	NS	.42	.38	.27

TABLE VI

COMPARISON OF VARIETIES AS TO BUDS DEVELOPING INTO SPURS WITHIN EACH TREATMENT

Shoot Length Over Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Lodi	8.22	7.85	8.00	6.05	8.20	6.40	3.74	6.25	4.35	1.55	2.45	1.60	.68	.50	.40
Cort.	3.05	4.00	3.94	2.50	5.60	3.05	2.11	3.35	3.05	2.11	3.35	2.16	.75	.53	.89
Jona.	--	8.61	9.44	--	7.77	7.72	--	6.21	6.22	--	2.32	2.18	--	.35	.65
E. Mc.	--	9.20	8.20	--	7.40	6.07	--	5.60	4.53	--	2.33	1.33	--	1.00	.53
LSD 1%	1.99	2.40	2.04	1.71	2.11	1.98	1.43	1.69	1.69	NS	NS	NS	NS	NS	NS
LSD 5%	1.48	1.80	1.51	1.26	1.56	1.47	1.06	1.25	1.25	NS	NS	.71	NS	.60	.47

Shoot Length Under Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Lodi	1.70	3.20	3.21	2.36	2.72	2.60	1.85	1.40	1.15	.85	.50	.75	.30	.40	.35
Cort.	.95	.95	.90	2.05	1.58	.50	1.90	1.39	.68	1.70	1.32	.37	1.21	.77	.11
Jona.	--	2.58	3.81	--	2.67	2.87	--	1.74	2.00	--	.61	.35	--	.23	.12
E. Mc.	--	4.20	3.50	--	3.80	3.14	--	2.67	2.21	--	1.13	.57	--	1.67	.43
LSD 1%	NS	1.43	1.43	NS	1.01	1.06	NS	.79	.76	.74	.60	NS	.57	.51	NS
LSD 5%	NS	1.06	1.06	NS	.75	.79	NS	.58	.56	.55	.45	NS	.42	.38	.27

Long Cortland shoots produced fewer spurs with a minimum amount of heading back than did Lodi, Jonathan and Early McIntosh, and these produced about the same number. All four varieties produced many less spurs, but about the same number when severely headed back.

Short Early McIntosh shoots developed more spurs with light pruning than the other varieties and Cortland developed the least number of spurs.

The difference between varieties in the number of buds per shoot remaining dormant within each treatment is shown in Table VII.

Long Lodi and Early McIntosh shoots had fewer buds remaining dormant when pruned up to one-fourth of the shoot length than did Cortland and Jonathan. With severe heading back, long Early McIntosh shoots had fewer dormant buds than did the other three varieties.

When short shoots were pruned to any degree, Lodi had fewer buds remaining dormant than the other varieties. Cortland had more buds remaining dormant with light pruning than did the other varieties.

III. COMPARISON OF THE TOTAL NUMBER OF BUDS ON EACH VARIETY

The varietal difference as to the total number of buds with each treatment is shown in Table VIII.

When long Jonathan shoots were not pruned, or had one-fourth of the shoot removed, there were more buds than on Cortland and Early McIntosh. However, there was about the same number of buds on Lodi as on the other three varieties. With severe heading back all varieties had just about the same number of buds.

Short Cortland and Lodi shoots with a minimum amount of heading

TABLE VII

COMPARISON OF VARIETIES AS TO BUDS REMAINING DORMANT WITHIN EACH TREATMENT

Shoot Length Over Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Lodi	5.00	6.50	4.30	5.26	4.95	3.80	3.47	5.20	3.45	3.00	2.70	2.90	1.32	2.50	2.20
Cort.	7.30	10.47	6.94	6.35	6.40	6.26	5.00	4.75	5.58	2.20	2.90	3.37	1.80	2.63	1.94
Jona.	--	6.50	6.44	--	5.00	6.55	--	3.95	4.89	--	3.26	2.29	--	2.94	2.24
E. Mc.	--	6.73	3.33	--	6.00	4.20	--	4.40	3.40	--	3.40	3.13	--	1.77	2.33
LSD 1%	1.99	2.40	2.04	NS	NS	1.98	1.43	NS	1.69	NS	NS	.95	NS	.81	NS
LSD 5%	1.48	1.80	1.51	NS	NS	1.47	1.06	1.25	1.25	.78	NS	.71	.47	.60	NS

Shoot Length Under Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Lodi	3.85	3.25	4.58	3.74	2.89	3.70	2.75	2.55	3.40	1.85	1.72	2.40	1.40	1.15	1.70
Cort.	5.37	6.05	6.84	4.25	4.47	5.78	3.30	3.39	4.16	1.95	2.58	2.95	1.53	1.71	1.89
Jona.	--	4.90	4.00	--	4.33	3.13	--	3.58	3.06	--	3.00	3.12	--	2.23	2.12
E. Mc.	--	4.20	4.57	--	4.13	3.21	--	3.33	2.71	--	2.60	2.57	--	1.67	1.86
LSD 1%	1.14	1.43	1.43	NS	1.15	1.06	NS	.79	.76	NS	.60	.59	NS	.51	.37
LSD 5%	.84	1.06	1.06	NS	.86	.79	NS	.58	.56	NS	.45	.44	NS	.38	.27

TABLE VIII

COMPARISON OF VARIETIES AS TO TOTAL NUMBER OF BUDS WITHIN EACH TREATMENT

Shoot Length Over Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Lodi	15.6	17.0	15.5	14.8	16.1	13.6	10.5	14.3	10.6	6.20	7.65	6.65	4.05	5.35	4.40
Cort.	14.4	17.1	14.9	12.6	16.4	12.6	10.2	11.9	10.1	7.26	7.85	6.68	4.20	5.32	4.61
Jona.	--	18.1	18.9	--	15.7	17.3	--	12.7	13.7	--	8.47	6.88	--	5.12	4.71
E. Mc.	--	17.6	14.1	--	15.0	12.5	--	12.1	10.5	--	8.00	6.67	--	4.46	4.33
LSD 1%	NS	NS	1.68	NS	NS	2.02	NS	2.06	1.82	NS	NS	NS	NS	NS	NS
LSD 5%	NS	NS	1.24	1.77	NS	1.50	NS	1.53	1.35	.99	NS	NS	NS	.82	NS

Shoot Length Under Ten Inches

Treatment	NP			TR			1/4 R			1/2 R			3/4 R		
Year	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961	1959	1960	1961
Lodi	6.60	7.50	9.05	7.79	7.17	7.70	5.95	5.20	6.00	3.80	3.72	4.35	2.85	2.60	3.00
Cort.	7.36	8.05	8.95	7.35	6.95	7.55	5.90	5.55	5.74	4.00	4.37	4.21	2.89	2.82	3.00
Jona.	--	8.90	9.00	--	8.67	7.40	--	6.74	6.22	--	5.11	4.40	--	3.46	3.00
E. Mc.	--	8.93	9.00	--	8.33	7.50	--	6.47	5.93	--	4.33	4.36	--	2.87	3.00
LSD 1%	NS	1.36	NS	NS	1.18	NS	NS	.69	NS	NS	.71	NS	NS	.51	NS
LSD 5%	NS	1.01	NS	NS	.88	NS	NS	.51	.46	NS	.52	NS	NS	.38	NS

back had fewer buds than did Jonathan and Early McIntosh. With severe heading back, Jonathan and Cortland had more buds than did Lodi and Early McIntosh.

IV. COMPARISON OF SHOOT AND SPUR PRODUCTION

Differences between the treatments within each variety relation to the number of shoots produced on shoot lengths longer or shorter than ten inches over the three year period is shown in Table IX.

On long Lodi shoots, the number of shoots produced when the terminal bud was removed was not significantly different from those having a terminal bud. However, as would be expected with an increase in severity of heading back, there was a significant decrease in the number of shoots produced. On Lodi shoots under ten inches in length there was a definite increase in the number of shoots when the terminal bud was removed compared to response with the terminal left on.

On long and short Cortland shoots, leaving or removing the terminal made no difference in number of shoots produced. As was the case with Lodi, with any increase in the amount of wood removed there was a decrease in the number of shoots produced in both shoot lengths.

Jonathan responded in a similar manner to Cortland. Early McIntosh showed even fewer differences between treatments as to the number of shoots developing. The only significant difference was that when one-fourth of the long shoot was removed, more shoots were produced than when one-half or three-fourths was removed, but never more than were produced by shoot more moderately pruned.

On shoots under ten inches the different treatments did not

TABLE IX

DIFFERENCE BETWEEN TREATMENTS FOR THE 2 OR 3 YEAR PERIOD RELATIVE TO THE NUMBER OF BUDS DEVELOPING INTO SHOOTS WITHIN EACH VARIETY PER SHOOT

Shoot Length Over Ten Inches

Variety	Lodi	Cortland	Jonathan	Early McIntosh
Treatment				
NP	2.78	4.00	3.00	2.10
TR	3.27	4.22	3.00	1.90
1/4 R	2.97	2.93	2.59	2.30
1/2 R	2.48	2.45	2.67	2.23
3/4 R	2.02	1.86	1.82	1.57
LSD 1%	.65	.74	.85	.73
LSD 5%	.48	.55	.63	.54

Shoot Length Under Ten Inches

Variety	Lodi	Cortland	Jonathan	Early McIntosh
Treatment				
NP	1.12	1.08	1.28	.72
TR	1.54	1.07	1.55	.76
1/4 R	1.35	.79	1.30	.72
1/2 R	1.26	.57	1.23	.90
3/4 R	1.05	.50	.87	.48
LSD 1%	.26	.34	.42	NS
LSD 5%	.19	.25	.31	.32

produce any practical differences in response.

Table X shows differences between treatments for each variety in number of spurs produced. The data follows the same pattern as with the number of shoots developing. With an increase in the amount of wood removed, regardless of original shoot length, there is a decrease in the number of spurs developing. In a few instances, such as with Cortland, the number of spurs developing on long shoots when the terminal bud was removed was equal to the number of spurs produced when the bud was left intact. This also was the case with short Jonathan shoots.

The conclusion may be drawn that removing a portion of a shoot does not increase the number of buds that will develop into shoots or spurs and that apparently apical dominance, even if temporarily destroyed, is soon re-established by the growth of an apical bud, which in most cases is on a shoot.

V. COMPARISON OF VARIETIES WITHIN TREATMENTS RELATIVE TO SHOOT AND SPUR PRODUCTION

A varietal difference was noticed in the number of shoots developing within each treatment on all shoot lengths as shown in Table XI. Early McIntosh produced fewer shoots than the other three varieties only when the terminal was left intact or removed. With further heading back, there was no varietal difference. When considering the spur data presented in Table XI, Cortland produced fewer spurs at the first three treatment levels than the other three varieties.

TABLE X

DIFFERENCE BETWEEN TREATMENTS FOR THE 2 OR 3 YEAR PERIOD RELATIVE TO THE NUMBER OF BUDS DEVELOPING INTO SPURS WITHIN EACH VARIETY PER SHOOT

Shoot Length Over Ten Inches

Variety	Lodi	Cortland	Jonathan	Early McIntosh
Treatment				
NP	8.03	3.65	9.03	8.70
TR	6.90	3.73	7.74	6.73
1/4 R	4.80	2.54	6.22	5.07
1/2 R	1.75	1.69	2.25	1.83
3/4 R	.66	.72	.50	.75
LSD 1%	1.09	.82	.48	1.40
LSD 5%	.80	.61	.34	1.04

Shoot Length Under Ten Inches

Variety	Lodi	Cortland	Jonathan	Early McIntosh
Treatment				
NP	2.69	.92	3.06	3.86
TR	2.56	1.40	2.76	3.48
1/4 R	1.47	1.51	1.86	2.45
1/2 R	.71	1.31	.48	.86
3/4 R	.35	.70	.17	.69
LSD 1%	.58	.46	.95	.91
LSD 5%	.43	.34	.70	.67

TABLE XI

COMPARISON OF VARIETAL RESPONSE BETWEEN TREATMENTS FOR THE 2 YEAR PERIOD (1960-61) RELATIVE TO BUDS DEVELOPING INTO SHOOTS AND SPURS ON ALL TREATED SHOOTS

Buds Developing Into Shoots					
Treatment	NP	TR	1/4 R	1/2 R	3/4 R
Jonathan	2.14	2.29	1.95	1.96	1.38
E. McIntosh	1.42	1.34	1.52	1.58	1.02
Lodi	2.06	2.35	2.09	1.85	1.50
Cortland	2.53	2.82	1.84	1.57	1.35
LSD 1%	.67				
LSD 5%	.50				

Buds Developing Into Spurs					
Treatment	NP	TR	1/4 R	1/2 R	3/4 R
Jonathan	6.04	5.32	4.04	1.35	.34
E. McIntosh	6.32	5.14	3.78	1.36	.72
Lodi	6.00	5.04	3.29	1.35	.51
Cortland	2.41	2.75	2.05	1.42	.57
LSD 1%	1.17				
LSD 5%	.87				

VI. COMPARISON OF VARIETIES FOR ALL TREATMENTS AS TO SPUR AND SHOOT PRODUCTION

Table XII shows that when all treatments are considered Cortland had fewer spurs than the other varieties, and there was no difference between the other three varieties. Early McIntosh produced fewer shoots than the other three varieties, which had an essentially equal number of shoots.

The two previous tables cited illustrate that there is a varietal difference in the number of buds developing into spurs or shoots. It appears that in order to modify these differences, if need be, such as lack of spurs on Cortland or shoots on Early McIntosh, methods other than heading back must be employed.

VII. RESPONSE OF THE ORCHARD BETWEEN TREATMENTS

Table XIII shows that the orchard responded to the treatments as each variety had responded. (See Tables IX and X.) With an increase in the amount of wood removed there is a decrease in the number of spurs or shoots produced.

TABLE XII

COMPARISON OF VARIETIES FOR TOTAL AMOUNT OF SHOOTS AND SPURS PRODUCED IN TWO YEARS ON ALL TREATMENTS PER SHOOT

	Spurs	Shoots
Jonathan	3.48	1.95
Early McIntosh	3.48	1.38
Lodi	3.15	1.97
Cortland	1.85	2.03
LSD 1%	.54	.30
LSD 5%	.40	.22

TABLE XIII

COMPARISON OF THE ORCHARD OVER THE THREE YEAR PERIOD BETWEEN TREATMENTS RELATIVE TO BUDS DEVELOPING INTO SHOOTS AND SPURS PER SHOOT

	Spurs	Shoots
NP	4.66	2.08
TR	4.23	2.32
1/4 R	3.07	1.92
1/2 R	1.37	1.73
3/4 R	.58	1.31
LSD 1%	.54	.29
LSD 5%	.40	.21

CHAPTER V

SUMMARY AND CONCLUSIONS

One-year-old apple shoots of four varieties were headed back with different degrees of severity during a three year period, and the response of buds as measured by production of shoots or spurs, or by remaining dormant was recorded.

Heading back, regardless of the severity or the variety, did not increase the number of buds developing into shoots or spurs, nor did heading back decrease the proportional number of buds remaining dormant.

On Lodi, Jonathan and Early McIntosh shoots over ten inches, the majority of buds developed into spurs. With an increase in the severity of pruning, more remained dormant than developed into shoots or spurs.

The majority of Cortland buds on shoots longer or shorter than than ten inches, regardless of the degree of heading back, remained dormant.

On shoots shorter than ten inches in length, regardless of variety or treatment, the buds remaining dormant predominated.

The varietal difference with regard to shoot production was negligible in most cases, regardless of treatment or original shoot length. However, when spur production is considered, Cortland produced the least number of spurs on shoots longer or shorter than ten inches with a minimum amount of heading back. Cortland also had more buds remaining dormant than the other three varieties.

In general, there was no difference between varieties in the total number of buds. An increase in the amount of wood removed, regardless of the original shoot length or the variety, decreased the number of shoots or spurs developing.

Regardless of varietal differences, the bud performance on long or short shoots did not change in proportional numbers until one-fourth or one-half of the original shoot length had been removed.

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