SOME EFFECTS OF PRUNING ON THE GROWTH OF APPLE TREES

by

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INTRODUCTION

Pruning is the practice through which, by cutting off of branches, pinching off of young shoots, or removal of undesirable buds, growth of the tree is directed to suit a certain ideal condition. It is concerned with the development of a mechanically strong tree with a large bearing area close enough to the ground to facilitate all of the cultural practices such as spraying, thinning, picking and other orchard operations. A mechanically strong tree should have strong crotches and well proportioned scaffold branches.

Similarly training has many effects in common directed toward producing a framework of branches arising from the main trunk, in such positions as to be symmetrically arranged around the central trunk and spaced far enough apart to avoid crowding when the tree reaches mature size and to eliminate narrow angled crotches. Pruning has certain mechanical and physiological effects which may or may not be beneficial, but cutting off some natural growth of any fruit tree is essential for keeping it open in order to do a thorough job of spraying, permit a good penetration of sunlight and free air circulation to all fruits. High quality and marketable fruit partly depend on proper pruning of the trees.

Some other effects of moderate to heavy pruning include delaying of fruiting, dwarfing and upsetting the balance of growth and fruitfulness. It can be seen, therefore, that the methods of pruning may result in detrimental effects. On the other hand, pruning is essential in order to distribute main scaffold branches around the tree in the proper position the right distances apart. Through pruning one can get rid of undesirable crotches which, if not removed, would result in breakage of the trees after they come into bearing.

Each successful fruit grower must make an effort in developing a type of tree that will have maximum strength in the framework branches which will support a full crop with little or no breakage. Selection of good main branches with wide angles prevents the trees from being attacked by wood-rotting fungi when it becomes old.

A comparatively large part of the pruning that the trees are to receive should be given during the first few years of their growth. It is during this period that they are building their framework and taking on the general form that the grower has decided should be theirs during the rest of their lives. During later years every attempt should be made to preserve the form already given the tree and attention is given to maintenance pruning as distinguished from tree building or training. The height of head of an apple tree, the distance from the ground of the lowest branch, has a marked effect upon the growth of the tree. The higher the head the smaller the tree and a lower productive capacity when it reaches bearing age. For this reason and because they are easier to spray, prune and harvest low headed trees are preferred. As indicated previously, the distribution of the scaffold limbs is extremely important. When all of them come out from the trunk at points close together they form bad crotches. When they are distributed over 1½ to 3 feet of trunk or more each limb has a chance to make more or less a good solid union. The number of scaffold limbs found in orchard trees varies greatly. A moderate number on apples, 5 to 8, usually is desirable in that it makes the tree mechanically strong and at the same time open enough to facilitate the necessary orchard operation. It has been shown by Verner (19) that crotch angles in Delicious apple trees are influenced strongly by the action of a plant hormone synthesized in portions of the tree distal to the crotch. The natural tendency for a narrow or wide included angle of scaffold

branches varies from clone to clone. The purpose of this study was to determine the effect of various pruning techniques on the growth habit of selected Golden Delicious and Delicious clones on seedling or clonal root-stocks.

REVIEW OF LITERATURE

Batjer (1) compared three methods of pruning at the end of the fourth growing season and found that with each variety tested in the experiment, heading at 30 inches at planting time produced a smaller number of narrow angled crotches than single or group disbudding.

Ruth and Kelly (15), working with 10 varieties of apples, compared the effect of three systems of training and no training on the crotch angles of primary framework branches. At the end of the fourth growing season there were no significant differences in the crotch angles of trained and untrained trees.

Talbert (17, 18) reported that when young trees were cut back to short stumps near the ground, wide angle, better placed branches were formed when compared with untreated trees.

Talbert also reported that the cut back trees at the end of the fourth year were as large as the uncut trees.

Horsfall (6) suggested that a large ratio of the trunk to limb diameter appears to be positively correlated in some way with wide crotches. Roberts (14) reported that the growth of nursery trees when topped is characterized the second year by narrow crotches on limbs close to the topping cut. The width of these angles increases with increasing distance from the upper end of the trunk. The greater the distance from the top the smaller is the average limb diameter.

Many textbooks and extension publications (4, 11, 16) suggest that on trees with only a few branches left growing during the first year more narrow crotches result than on trees where a larger number of branches are allowed to grow. They further suggested restricting the number of original branches to be especially undesirable with varieties which have an upright character of growth. However, there is general agreement that when only a few branches are allowed to grow, the total growth per shoot is greater when compared with trees on which a larger number of branches are allowed to grow.

Horsfall and Vinson (8) reported that wide angles in the cut back trees are due to the rapid enlargement of the trunk which may redirect an upright shoot to a more horizontal position because of mechanical pressure of the trunk against the shoot which is pliable in its early growth. They further reported that the lower lateral buds on a one year old tree lie with their axes farther from the vertical than buds higher on the trunk; therefore, scaffold branches growing from such buds have wider angles.

Verner (19, 20) reported that wide angle crotches result partially from the action of a plant hormone formed in the growing point of the young trees. When it moved downward through the phloem, its action changed the direction of growth of the shoot towards a horizontal position. He further stated that when indolebutyric acid in a lanolin paste was allowed to diffuse slowly over a long period into the cut terminal portions of the apple whips cut back to 30 inches while dormant, that wider crotch angles were developed throughout the tree.

Bukovac (3), using one year old Delicious apple trees, found that 2,3,5-tri-iodobenzoic acid (TIBA) increased the angle of primary branches on an average of 10 degrees with sprays of 30 ppm and a mean of 14 degrees at 50 ppm concentration. The sprays were applied to the foliage two weeks

after bloom.

Preston (13), working with plum trees, found that 90 mg of indolebutyric acid per 100 gram of lanolin emulsion resulted in wide crotch angles in the primary framework branches. He also reported that higher concentration depresses the growth of the first three branches. He suggested the practice as a practical way of building up the structural strength of plum trees so they are less subject to framework breakage under heavy crops.

He indicated that branches 4 to 6 from the tip had wide crotches regardless of whether growth substance were applied. He suggested that one way of avoiding narrow crotch angles in the framework is to cut back one year old trees 10 or 15 cm above the point to which the trunk is to be shortened, let six primary branches grow the first year and ultimately head back the tree to the fourth branch the following winter.

Horsfall and Vinson (7) reported that tissue in crotches of wide angles appears to mature earlier and were found less injured by cold. They concluded that the resistance of crotch tissue to low temperature seems to be correlated with the width of the crotch angle.

MacDaniels (10) found that in wide angle crotches the woody tissues of the formed branch were strongly united with adjacent woody tissues of the trunk, thus he reasoned that branches with wide angle are strong and can withstand heavy loads of fruit.

Miller (12), in studying the influence of crotch angle on the breaking point of apple tree branches, found that a great number of branches which had angles of less than 45 degrees broke under stress at the crotches. However, branches with angles of 45 degrees or more were themselves broken under the same stress. He concluded that the percentage of branches breaking at the crotches decreased as the crotch angle increased. He also

reported that wide angle branches tended to be shorter than narrow angle branches. He believed that the lower breaking stress at the crotch angle is the result of fast rate of growth in the woody tissues at this location.

Harvey (9) proposed that, the smaller the crotch angle, the smaller the proportion of tissue common with the trunk.

Black (2) found that if the crotch angle at the point of union is less than 40 degrees, the branch is weak. He reported that if a branch leaves the trunk at 60 degrees or more, such a branch may be very strong. He observed in year old nursery and orchard trees that there was a correlation between the length of year old shoots developing from the trunk and the width of crotch angles which they formed with the trunk.

He further suggested that late planting of apple trees in the spring in regions of high temperature may favor the formation of narrow crotches even if the trees do not make a large total volume of twig growth.

Roberts (14) reported that if the selected branches are too low then bad crotches will be formed. He suggested that the highest branch grows almost in the same direction as one from which it arises, and the lower branches make a wider angle which later on results in a spreading type tree.

MATERIALS AND METHODS

Three methods of training were employed at the university experimental farm in order to measure the effect of different methods of training upon the angle of current year scaffold branches and general growth of apple trees.

Dormant year old whips of Delicious and Golden Delicious trees on seedling and clonal rootstocks were planted in the spring of 1964 and trained according to the following methods.

1. Normal pruning which was used as control -- In this method trees were cut back to a height of 36 inches immediately after planting and no further pruning was given during the first growing season.
2. Delayed heading back -- Trees receiving this treatment were cut back after planting to 42 inches, six inches above the desired height. A second cut was made at approximately the 36 inch height after the uppermost branches reached a length of 4 to 6 inches. No further pruning was done after the heading back operation till the end of the first growing season.
3. Use of synthetic growth substance -- Trees receiving this treatment were cut back to a height of 36 inches (normal pruning) before growth started. Thirty-five days later on May 15, when the growth advanced and most of the buds and shoots made a growth of 3 to 4 inches, the trees were sprayed with an aqueous solution of 50 ppm TIBA applied to the foliage. No further treatment was given till the end of the first growing season when the data were recorded.

For all treatments a minimum of 32 trees were planted and a minimum of 8 single tree replications per rootstock were planned originally. As a result of tree losses, this number was reduced to five single tree replications.

When the data were taken, five branches per replication were employed which later were selected as main scaffold branches. After the losses were taken into consideration, a total of 25 branches per rootstock was used in the test.

Branch angles were measured at a distance 3 inches above the crotch. Spread of branches was measured in a horizontal distance from the central axis to the center of the branch at a point 12 inches above the crotch.

Circumference of the trunk was measured 6 inches above the ground. Circumference of the scaffold branches was measured two inches above each crotch.

The experimental farm is located in the Kansas River Valley. The soil is a fertile sandy silt loam. No fertilizer application was made to the trees. Irrigation water was applied three times during the growing season, and a total 24.1 inches of rain fell from April 1 to October 31. Three times during the growing season the trees were cultivated to reduce weed competition with the trees. The design of planting consisted of a completely randomized selection of treatments. There were a total of 224 trees set out.

Cultivar-Rootstock Combinations

a. Delicious on seedling rootstocks.

b. Delicious spur type (Starkrimson) on seedling rootstocks.

c. Delicious with East Malling II as an interstem on seedling rootstocks.

d. Delicious on Clark dwarfing stock.

e. Golden Delicious on seedling rootstocks.

f. Golden Delicious spur type (Yellow Spur) on seedling rootstocks.

RESULTS

Delicious Trees

After the data were recorded, the angles of the scaffold branches from the different treatments were subjected to an analysis of variance. There were no significant differences in measured included angles observed between pruning treatments. However, the interaction between the stocks and treatments or pruning were found to be highly significant.

Table 1. Analysis of variance of the average crotch angles of branches on one year old trunks of Delicious apple trees, measured 3 inches above the crotch.

Source	DF	Sum of squares	MS	F
Replications	4	113.15	28.29	1.18 N.S.
Stocks	3	274.57	91.52	3.81 *
Treatments	2	2.44	1.12	.05 N.S.
Stocks x Treatments	6	492.66	82.11	3.42 **
Error	44	1056.71	24.02	

N.S. No statistical significance

** Significant at 1 percent level

* Significant at 5 percent level

The different rootstocks varied in response to the different pruning treatments. The L.S.D. values were calculated, and the average differences are given in Table 2.

When comparing the average values of the included crotch angles for all controls, it was found that those of the spur type Delicious on seedling understocks were significantly wider than Delicious on EM II interstems and Delicious on Clark understock. Also the crotch angles of Delicious on seedling understocks were found to be significantly wider than those measured on Clark understocks.

There were no significant differences in average values of crotch angles between any of the cultivar-rootstock combinations of trees receiving the delayed heading back treatment.

The crotch angles of Delicious trees on seedling roots sprayed with TIBA had significantly wider crotch angles than Delicious spur type on seedling

rootstocks and Delicious on EM II interstocks which also were sprayed with the same chemical.

Comparisons of the effects of the pruning treatments on the various Delicious-rootstock combinations revealed that the trees of the Delicious on Clark understocks sprayed with TIBA and those receiving the delayed heading back had significantly wider angles than the controls. However, for the Delicious spur type on seedling roots, the exact opposite was found, the angles of the controls being significantly wider than those of the other two treatment groups. These differences reflect the significant stock-treatment interaction which was found in the analysis.

Table 2. The effect of different training methods on the crotch angle of the scaffold branches shown by the average values in degrees.

Cultivar-Rootstock combinations	Treatments		
	Control	Delayed Heading Back	TIBA
Delicious spur type on seedling roots	65.8	58.8	59.0
Delicious on seedling roots	60.0	63.0	65.4
Delicious on EM II interstocks	56.3	57.4	56.0
Delicious on Clark understocks	52.1	60.5	59.4

L.S.D. = 6.25 at 5 percent level

Observations of the effect of the different pruning treatments on the spreading of the scaffold branches as measured 12 inches above the crotch from the central axis to the center of the branch. As seen in Table 3 there were no great differences in the spread of the scaffold branches as a result of the different pruning treatments on the various rootstocks.

Table 3. Effect of the three methods of training upon the spreading of the branches, circumference of the trunk, circumference of the scaffold branches, and length of the scaffold branches.

Methods of training	Avg. spread of branches in cm.	Avg. circumference of the trunk in cm.	Avg. circumference of the branches in cm.	Avg. length of branches in cm.
		Delicious Spur type on seedling understocks		
TIBA sprays	20.75	6.75	2.44	49.50
Delayed heading back	21.36	7.09	2.45	53.81
Control	22.51	7.07	2.58	51.72
		Delicious on seedling understocks		
TIBA sprays	21.34	5.95	2.40	55.88
Delayed heading back	20.77	6.50	2.40	55.77
Control	20.46	6.24	2.40	55.78
		Delicious on EM II interstems		
TIBA sprays	21.99	7.06	2.19	52.56
Delayed heading back	21.24	6.01	2.25	58.66
Control	20.49	7.36	2.38	58.22
		Delicious on Clark understock		
TIBA sprays	19.40	6.81	2.32	51.35
Delayed heading back	20.50	6.50	2.29	48.49
Control	16.36	6.20	2.28	49.39

At the 12 inch height all the branches, regardless of treatments, and rootstocks were almost an equal distance from the main trunks.

Trunk circumferences of each tree were measured in centimeters 6 inches above the ground. There was small variation in trunk circumference within each treatment group or between groups receiving different pruning treatments (Table 3).

Similarly circumferences of 5 scaffold branches on each tree were measured in centimeters, and the averages of these were used in determining the effect

of various pruning treatments upon the circumference of the scaffold branches (Table 3). There were no significant differences as a result of the different treatments.

The effect of different experimental treatments upon the total shoot growth was studied. The total length of an average of 25 branches per root-stock were measured in centimeters. Growth in total length of the branches was not greatly affected by the different pruning treatments. Considerable uniformity in total length of the branches was observed.

Golden Delicious Trees

Data presented in Table 4 show a noticeable difference in crotch angles as a result of different methods of pruning and chemical treatment. However these differences were not significant within a cultivar-stock combination.

Table 4. The effect of different methods of training on the crotch angle of scaffold branches.

Cultivar-Rootstock combinations	Treatments		
	Checks	Delayed Heading Back	TIBA sprays
Golden Delicious on seedling understocks	67.7	78.0	72.4
Golden Delicious spur type on seedling understocks	61.0	62.7	58.4

L.S.D. = 9.51 at 5 percent level

The data in Table 4 show that trees receiving the delayed heading back treatment had the widest crotch angle followed by those sprayed with TIBA for the standard Golden Delicious cultivar.

However, when the spur type Golden Delicious trees were compared, little difference in crotch angles were found.

On the basis of rootstock-cultivar comparisons the trees of standard Golden Delicious had wider crotch angles in all treatment categories when compared to the spur type trees. The standard Golden Delicious trees showed an average of 7 degree wider angles in control treatments. From Table 4 it can be seen that these crotch angles were significantly wider in trees of the standard Delicious cultivars that were headed back and sprayed with TIBA than for the spur type receiving the same treatment.

The spread of the scaffold branches, measured 12 inches above the crotch from the center of the trunk, was measured. The data in Table 5 show that there were no great differences in spread of the branches as influenced by the different treatments on either cultivar-rootstock combinations.

Table 5. Effect of the three methods of training upon the spreading of the branches, circumference of the trunk, circumference of the branches, and total length of the branches.

Methods of training	Avg. spreading of the branches in cm.	Avg. circumference of the trunk in cm.	Avg. circumference of the scaffold branches in cm.	Avg. total length of the branches in cm.
	Golden Delicious on seedling understock			
Sprayed with TIBA	20.98	6.31	2.32	61.17
Delayed heading back	22.11	6.48	2.33	55.35
Control	20.75	6.45	2.24	54.19
	Golden Delicious spur type on seedling understock			
Sprayed with TIBA	18.15	7.60	2.40	49.15
Delayed heading back	20.54	7.07	2.17	37.61
Control	18.97	7.38	2.53	53.74

Measurements of the trunk and the scaffold branches circumferences (Table 5) did not reveal any considerable differences as the result of different pruning-treatments of the cultivar-rootstock combination.

No great differences in total shoot growth were observed between treatment groups for either cultivar-understock combination.

Table 6. Analysis of variance of the average crotch angles of branches on one year old trunks of Golden Delicious apple trees, measured 3 inches above the crotches.

Sources	DF	SS	MS	F
Replications	4	174.42	43.60	00.84 N.S.
Stocks	1	1070.42	1070.42	20.59 **
Treatments	2	200.23	100.12	1.93 N.S.
Stock x treatments	2	106.47	53.24	1.02 N.S.
Error	20	51.98	51.98	
Total	29	2591.07		

** Significant at 5 percent level

N.S. No statistical significance

DISCUSSION

From the data recorded in this study it was seen that wide crotch angles were not formed consistently as a result of delayed heading back or TIBA sprays applied to Delicious apple trees. Generally the delayed heading back resulted in wider crotch angles than was formed on trees pruned only once after planting. However, only on the Delicious-Clark-seedling interstock combinations and Spur type Delicious on seedling rootstock were these differences significant. Verner (20) reported that delayed heading back

consistently gave rise to wider crotch angles than normal pruning of Delicious.

Trees with branches symmetrically arranged around their axis produced wider angle crotches as compared to trees with a few branches as proposed by Verner. Delayed heading back treatment gave uniformly wider angles in Golden Delicious trees on seedling understocks than trees conventionally pruned although these differences weren't statistically significant.

The tendency of a branch to form a narrow angle depends upon the scion variety and rootstock on which it was grown more than on the method of training. Golden Delicious on seedling rootstocks consistently had wider crotch angles than Delicious on seedling stocks regardless of the experimental treatments. However, differences between the spur types of both cultivars were variable and without a definite pattern. TIBA at 50 ppm sprayed over the foliage of Delicious and Golden Delicious whips after growth started in the spring did not show any apparent effect on crotch angles except for the Delicious or Clark understock which were wider than the control trees. Bukovac (3) reported that TIBA increased the angle of branches in Delicious trees 10 degrees with sprays of 30 ppm, an average of 14 degrees with 50 ppm sprays. TIBA sprays applied at 50 ppm concentration did not show any growth retardation.

The width of the angle did not show any positive effect on the spread of the branches. Branches that left the trunk at a relatively wide angle, had almost the same spread as branches which left the trunk at narrow angles.

This study didn't support the observation made by Blake (2) that rapidly growing branches tend to cause the formation of narrow angles. In many instances it was observed that rapid growing branches had wider angles than many of the weaker growing branches. Trunk diameter in this study showed some positive effect upon the widening of crotch angle, especially with Golden

Delicious on seedling combinations. This effect was observed in the lower portion of the trunk, about 8 to 12 inches above the ground in the rapidly growing trees. But it usually was not the case with Delicious on clonal rootstocks. This study supports the theory of Horsfall (6) that a large ratio of trunk to limb diameter appears to be positively correlated in some way with wide crotches.

This study also supports the observation of Roberts (14) that very low branches formed bad angles, and that high branches grow upward. Branches which were suitable as the primary framework pushed out from the middle portion of the trunk at a wider angle and grow outward up to a certain distance and then started growing upward.

Wind showed some effect in decreasing crotch angles, and spreading the branches in this study. The prevailing wind at the Horticulture farm was from the southwest. It can be seen in plates II, III, IV that the branches on the windward side bent toward the center of the tree and their crotch angle and spread decreased.

It is interesting to see that no consistent difference in trunk circumference resulted from the different methods of training (Tables 3 and 5). Ruth and Kelly (15) reported an increase in trunk circumference as the result of heading back as compared with disbudding.

Similarly no differences were observed in the circumference of the scaffold branches (Tables 3 and 5) as a result of the different pruning treatments.

Some differences were found in the total shoot growth as the result of different treatments. As seen in Table 3 Delicious trees on EM II interstems sprayed with TIBA showed an average of 6 cm less shoot growth as compared with trees receiving the two other treatments. Also the Golden Delicious spur

type trees receiving the delayed heading back treatments had an average of 11 cm less shoot growth than trees in the other treatment groups. This is probably due to the weakness of the growth of the spur type trees.

According to Verner (20) the length of a given branch produced on a whip is usually inversely proportional to the supply of hormone reaching it from growing points above. The greatest growth usually is made by the upper most branch, followed by the second, third and fourth. In this study, the observation was not found to be absolute. Single branches from seedling understocks were longer in general than those arising from trees on clonal stocks. Many instances were observed in which trees with more than 15 branches had a given branch of more than 65 centimeters long regardless of the position of the branch on the trunk (plates II, IV, V). On the other hand, trees were found with a total of six branches or less branches in which the length of a given branch was not more than 30 cm. Therefore, it could be concluded that the length of a given branch is directly proportioned to the vigor of the tree regardless of the number or position of the branches on the trunk.

EXPLANATION OF PLATE I

Standard Delicious with normal pruning. Note the upper most cluster of branches just below the cut which grew with very sharp angles.

PLATE I

EXPLANATION OF PLATE II

Standard Delicious tree sprayed with a TIBA solution.

PLATE II

EXPLANATION OF PLATE III

Golden Delicious on seedling rootstock sprayed with a TIBA solution. Note the effect of wind on the angle and spread of the branches on the windward (right) side.

PLATE III

EXPLANATION OF PLATE IV

Spur type Golden Delicious on seedling rootstocks sprayed with a TIBA solution. Note wide angles and the shorter shoot growth of the upper limbs.

PLATE IV

EXPLANATION OF PLATE V

Golden Delicious spur type on seedling roots sprayed with a solution of TIBA. Note the enlarged trunk and the wide angle of scaffold branches on the lower third of the trunk.

PLATE V

SUMMARY AND CONCLUSION

Data and observations obtained in this study show that there were no significant differences in crotch angle as the result of different pruning treatments. The interaction between the stocks and treatments were highly significant in trees of the Delicious cultivar.

The crotch angles of most trees of Delicious combinations with the various rootstocks and interstocks that were headed back were wider than those receiving normal pruning. In contrast, the spur type Delicious on seedling understock pruned normally had significantly wider angle than Delicious on EM II interstock and Delicious on Clark understock. Also Delicious on seedling root understock headed back and sprayed with TIBA showed significantly wider angles than Delicious on Clark understock.

The crotch angle of Delicious trees on seedling rootstock sprayed with TIBA had significantly wider angles than Delicious spur type on seedling rootstock and Delicious on EM II interstock which also were sprayed with the same chemical.

Trees on Clark understock sprayed with TIBA and those receiving delayed heading back had significantly wider angles than the controls. But the opposite was found to be true with the trees on seedling rootstocks.

There were no major difference observed as result of various pruning treatments on the spreading of the branches, circumference of the trunks, circumference of the scaffold branches and total length of the branches.

Golden Delicious trees on seedling rootstocks had wider angles than spur type trees on seedling understocks. These differences were significant for trees headed back and those sprayed with TIBA. Comparison of the effect of the treatments showed that trees headed back had wider angles than those

sprayed with TIBA and those pruned normally.

There were no great effects of different experimental treatments on the Golden Delicious trees in the spreading of the branches, circumference of the trunk and circumference of the scaffold branches.

Golden Delicious spur type trees receiving delayed heading back treatments had an average of 11 cm less total shoot growth.

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Pruning is the practice through which, by cutting off branches, pinching off young shoots, or removal of undesirable buds, growth of the tree is directed to suit a certain ideal condition. It is concerned with the development of a mechanically strong tree with large bearing area close enough to the ground to facilitate all of the cultural practices such as spraying, thinning, picking and other orchard operations. A mechanically strong tree should have strong crotches and well proportioned scaffold branches.

Three methods of training were employed at the university experimental farm in order to measure the effect of different methods of training upon the angle of current year's scaffold branches and general growth of the trees.

Dormant one-year-old whips of Delicious and Golden Delicious trees on seedling and clonal rootstocks were planted in the spring of 1964 and trained according to the following methods. (1) normal pruning (2) delayed heading back (3) use of synthetic growth substance 2,3,5-tri-iodobenzoic acid (TIBA). For all treatments 5 single tree replications constituted a treatment block.

When the data were taken, five branches per replicate were selected as main scaffold branches.

Branch angles were measured 3 inches above the crotch. The spread of the branches as determined by measuring from 12 inches above the crotch to the center of the branch. Circumference of the trunk was measured six inches above the ground and the circumference of the branches as taken 2 inches above the crotches.

Cultivar combinations used were: (a) Delicious on seedling rootstocks, (b) Delicious spur type (Starkrimson) on seedling rootstocks, (c) Delicious with East Malling II as an interstem on seedling rootstocks, (d) Delicious on

Clark dwarfing stock, (e) Golden Delicious on seedling rootstocks, (f) Golden Delicious spur type (yellow-spur) on seedling rootstocks.

After the data were recorded the angle of the scaffold branches of the Delicious cultivar from the different treatments were subjected to an analysis of variance. There were no significant differences measured in crotch angle as a result of pruning treatments. However, the interaction between stocks and treatments was found to be highly significant.

When comparing the average values of the included angles of the crotches on all controls, spur type Delicious had significantly wider angles than Delicious on EM II interstems and Delicious on Clark understocks. Also the crotch angles of Delicious on seedling understocks were found to be significantly wider than those measured on Clark understock.

The crotches of Delicious trees on seedling rootstocks sprayed with TIBA had significantly wider angles than Delicious spur type on seedling and EM II interstock.

Trees on Clark understock sprayed with TIBA and those receiving delayed heading back had significantly wider angles than the controls. The opposite was found to be true with Delicious spur type trees on seedling rootstocks.

Golden Delicious on seedling rootstocks had significantly wider angles than spur type trees on seedling understocks. Comparison of the effect of the treatments showed that trees receiving delayed heading back treatments had wider angles than those sprayed with TIBA and those pruned normally.

There was no great effect from the different treatments on the Delicious and Golden Delicious trees in the spreading of the branches, circumference of the trunks, and circumferences of the branches and total length of the branches with minor exceptions.