Size of Peaches and Size of Crop
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East Lansing, Michigan

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Regardless of price fluctuations, large peaches almost always sell for more than small peaches. The growers' aim, naturally, is to produce the greatest possible number of large fruits. Two of the principal cultural practices, pruning and thinning, used to produce large fruits, result in a reduction in the total number of fruits. If the increase in size of the fruits harvested compensates for the decrease in numbers, these practices are profitable; when, however, the increase in size of fruits is accompanied by a decrease in number of bushels harvested, profit depends on the difference in value of the various grades and on the extent to which yield is sacrificed to grade. These two factors act simultaneously and rarely can they be separated. This bulletin sets forth the results of an inquiry into the operation of some factors which affect yield and size of fruit under conditions rather typical of Michigan peach orchards.

The present importance of size of fruit and the extent to which fruit growers are penalized for undersized fruit are illustrated by the data summarized in Tables 1 and 2. In 1926, but 70 per cent, and in 1927 only 60 per cent of the peaches handled by two fruit growers' cooperative associations and by two canneries met the specifications for A-grade size (minimum diameter two inches). These averages represent all varieties handled and may be considered typical (Table 1). Table 2 affords some idea of the importance that is placed on size by the canning trade. In 1926 and 1927, most canneries did not consider the packing of peaches under 1¾ inches in diameter to be worth while.

Table 3 gives the average prices received by two cooperative ship-

Table 1.—Peach sizes as delivered at two cooperative fruit growers' exchanges and at two commercial canning establishments in western Michigan, seasons of 1926-1927

Establishment	1926			1927		
	Percentage above 2 inches in diameter	Percentage 1¾-2 inches in diameter	Percentage below 1¾ inches in diameter	Percentage above 2 inches in diameter	Percentage 1¾-2 inches in diameter	Percentage below 1¾ inches in diameter
Shipping Association No. 1	80	12	8	58	33	9
Shipping Association No. 2	77	23	.....	69	31	.....
Cannery No. 1	60	40	.....	57	43	.....
Cannery No. 2	60	31	9	58	28	14

Table 2.—Average prices per bushel paid for Elberta, Kalamazoo, and New Prolific peaches of different sizes by a Michigan cannery during the 1924-1927 period

Year	Over 2 inches in diameter	2-1¾ inches in diameter	1¾-1½ inches in diameter	Under 1½ inches in diameter
1924	$1 75-2 10	$1 40	$0 75	$0 75
1925	1 50	1 00	0 65	0 65
1926	1 00	65	.....	.....
1927	1 50	1 10	.....	.....
Average	$1 44	$1 04	.....	.....

Table 3.—Average prices per bushel paid by two cooperative fruit shipping organizations for peaches of different sizes, 1925-1927

	Year	2 inch minimum diameter	1¾-2 inches diameter	Less than 1¾ inches diameter
Shipping organization No. 1	1925	$2 45	$1 65	.....
	1926	1 30	85	.....
	1927	1 95	1 30	.....
Shipping organization No. 2	1926	1 40	90	$0 50
	1927	1 75	1 35	70

ping organizations for peaches of different size during the 1925-1927 period. It will be noted that, though the relative value of 2-inch and 1¾-inch fruit varies somewhat from year to year, the quarter inch difference in size is as a rule, associated with nearly a 50 per cent difference in price.

From the grading and price data that have been presented, it is evident that the peach producer's income will be greatly increased and his profits perhaps doubled or tripled if he can materially increase the size of the fruit without too great an expenditure of time or money and without materially reducing yield.

The orchard practices, aside from cultivation which is taken for granted in peach culture, possessing most obvious connection with size and yield of fruit are fertilization, pruning, and thinning.

Description of Orchards

The so-called "Corporation" orchard, in which a portion of these experiments were conducted, is located near South Haven, about three miles from Lake Michigan. The land is comparatively level. The surface soil is a uniform light sandy loam, but varies in depth from seven or eight to 10 or 12 inches; and it is underlain by a sandy or gravelly subsoil. The orchard tract, of which this particular block of trees was a part, had been growing peaches for 60 years at the beginning of this experiment in 1924, a fact that in itself affords some measure of its suitability for peach culture. At the beginning of the experiment, the trees were 16 years old, were medium size for their age, and were in a medium state of vigor. The trees, all of the Kalamazoo variety,

were set 20 x 20 feet and before the spring pruning the branches of adjoining trees nearly met in the row. In the block selected for experimental treatments, eight tree rows wide and 25 tree rows long, there were six trees missing and 24 younger replants. During the course of the experiment, two trees in one of the plots showed symptoms of the "Little Peach" disease and were removed. Several others were so badly injured by a wind storm which occurred in August, 1925, that further records were not obtained from them. The plots, originally laid out to include 20 trees each, were therefore not exactly uniform in numbers of trees at the outset and they were even less uniform at the close of the experiment. The trees themselves, however, were as uniform at the beginning as one could expect to find in a Michigan peach orchard of that age. They were so uniform in their diversities at the close of the experiment, i. e., the different plots presented such striking differences and the trees within each plot were so uniform, that there was no doubt as to the way in which they had responded to the treatments that had been afforded. Throughout the course of the experiment they were under a clean culture, cover crop system of soil management and received the regular spray applications generally recommended for peaches in the district.

The Warsco orchard, located near Berrien Springs, contained only Elbertas set in 1923, 16½ x 16½ feet apart. The orchard soil is a reasonably fertile medium clay loam, apparently uniform throughout the area devoted to experimental treatments. The soil, like that in the Corporation orchard, had been under a clean culture, cover crop system of management. No fertilizer had been applied to the orchard up to the beginning of the experimental work in the spring of 1926. There was a perfect stand of trees and they had made a vigorous and uniform growth. Plots in this orchard were laid out in the form of single rows of 20 trees each.

The Graham Station orchard, near Grand Rapids, was set in the spring of 1920 on comparatively level land. The soil is a medium heavy, deep clay loam and is fertile and well drained. The trees, of the Gold Drop variety, were set 20 x 20 feet apart and had made a uniformly vigorous growth at the time the pruning experiment was started in the spring of 1924. This orchard, like the others, was maintained under a clean culture, cover crop system of soil management. The plots in this orchard consisted of five trees each and each treatment was duplicated in another part of the orchard. No fertilizers were applied to any of these plots during the course of the experiment; the differences in treatment consisted of variations in the amount and the kind of pruning and in thinning the fruit.

Seasonal Conditions

Weather conditions throughout the period covered by this investigation presented about the range that is usual in western Michigan. The winter of 1923-24 was not unusually severe but a sharp freeze in January resulted in the killing of over half the fruit buds of the Kalamazoo variety. Conditions during the blossoming period were none too favorable for fruit setting. The summer months were characterized by normal temperatures and rainfall. The crop was below medium in size.

The winter of 1924-25, like that of 1923-24, was not on the whole, unusually severe but low temperature during late December and early January resulted in much bud killing, a type of bud killing evidently more closely associated with immaturity than with conditions of atmospheric drought or any premature breaking of the rest period. A late frost in the spring of 1925 still further reduced the possibility of a full crop. Indeed, it was one of the lightest peach crop years Michigan has had for a considerable period.

Both the winter of 1925-26 and the spring of 1926 were favorable from the standpoint of freedom from freezing and frost injury. Trees throughout the state set and matured a heavy crop. The early part of

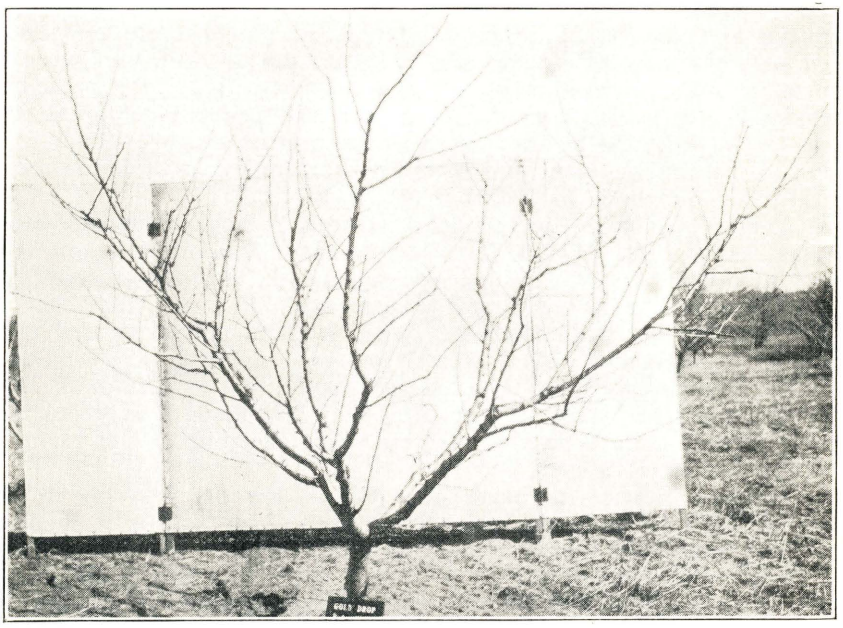

Figure 1.—A typical 6-year old Gold Drop peach tree after receiving a severe dormant pruning, consisting in both thinning out and heading back. Photo taken in April, 1927.

the growing season was characterized by comparatively low rainfall but this deficiency was made up during later summer and fall months and conditions were consequently favorable for the proper sizing of the fruit.

Weather conditions during the winter of 1926-27 and the spring of 1927 varied considerably from place to place. In the northern part of the "fruit belt" there was a rather general killing of fruit buds; and a form of early winter injury commonly known as blackheart resulted at the Graham Station. In southwestern Michigan there was comparatively little injury and a full crop was harvested from the Warsco orchard in Berrien County where one series of plots were under observation. There was plenty of rainfall during the early part of the grow-

ing season but the summer was practically without precipitation. Many orchards showed the effects of drought. However, the soil of this particular one was such as to enable the trees to endure a long dry period comparatively well.

PRESENTATION OF DATA

Fertilization

Soil fertility is generally recognized as one of the most important factors affecting the vigor and productivity of peach trees. Experimental work in a number of states has demonstrated the value of nitrogenous fertilizers in the peach orchard and many growers have found that these applications have paid good dividends. Though the experiments with fertilizers presented here have yielded results similar to those reported by several other experiment stations and add little to the general information already available, they should be interesting to Michigan peach growers. In addition, they provide a suitable background for a discussion of some of the other phases of peach orchard management.

Table 4.—The influence of fertilizer applications on shoot length[1], fruit bud formation and winterkilling of fruit buds. Average random samples of 100 shoots. Sixteen-year-old Kalamazoo peach trees

	Check plot		Fertilizer alone		Winter pruning alone		Winter pruning and fertilizer	
	1925[2]	1926[2]	1925[2]	1926[2]	1925[2]	1926[2]	1925[2]	1926[2]
Average shoot length (in inches)	1.9	4.4	3.2	5.3	9.9	10.1	7.6	9.6
Average number of fruit buds per shoot	4.9	9.4	6.7	8.4	12.6	18.2	9.8	18.2
Average percentage live fruit buds	59	71	74	66	39	60	45	66

1. Both shoots and short spur-like fruiting laterals are grouped together here.
2. Data obtained in the spring for the shoot growth of the preceding season.

Shoot Growth, Fruit Bud Formation, and Winterkilling of Fruit Buds—Data presented in Table 4 show the influence of fertilizer applications, of current and preceding years, on the 1924 and 1925 shoot growth of the old Kalamazoo trees and on the amount of winterkilling of the fruit buds on this growth. The general effect of the fertilizer was to increase shoot length. This increase does not appear striking because the records for lengths of the short spur-like laterals, of which there were great numbers, were averaged with the lengths of the terminals, and because fertilization usually has comparatively little influence on these spur-like growths. The figures on number of fruit buds per shoot and on the percentage of winterkilling are not entirely consistent, owing, perhaps, to the fact that only 100 shoots were selected from each plot for detailed record taking. In a general way, however, they show that the longer shoots carried more fruit buds

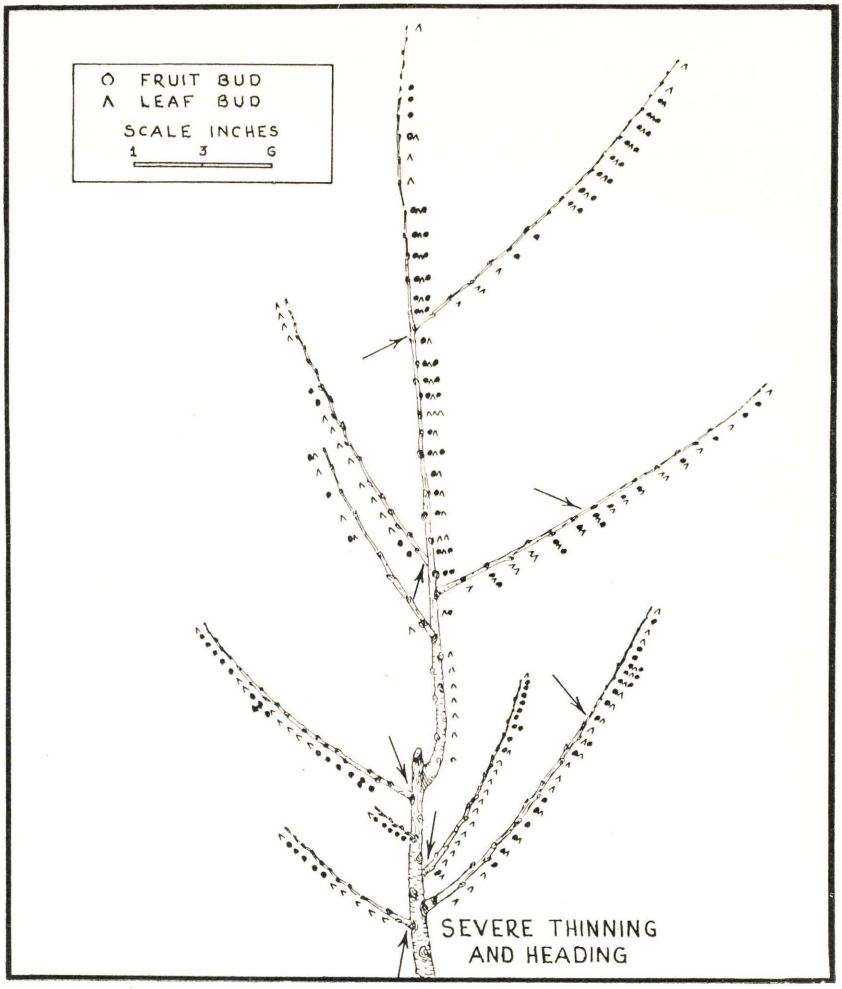

Figure 2.—Characteristic shoot growth resulting from severe dormant season pruning. The arrows indicate where cuts would be made in pruning this back another year if this system of pruning were to be continued. Note the number and distribution of the fruit buds on this shoot growth—fruit buds being indicated by (●) and leaf buds by (∧).

than the shorter ones, though a somewhat larger percentage of these were winterkilled. It was obvious to any observer that these unfertilized trees possessed plenty of fruit buds for a full crop. Doubtless, there are many peach orchards where fertilization is desirable from the standpoint of increasing the number of fruit buds but, probably, in the great majority of cases, fertilization is useful principally for other reasons. Furthermore, it may be doubted if fertilizer applications are warranted under average Michigan conditions from the standpoint of contributing to the hardiness of the buds to winter cold.

Yield and Size of Fruit—The figures (Table 5) showing the 1924-1926 yields from these same plots, however, tell a different story. Applications of nitrogen carrying fertilizers have uniformly resulted in greatly increased yields. These increases are evident in both pruned and unpruned trees and in years of heavy and of light crop production. An application of three pounds of sulphate of ammonia to each tree that had received a moderately heavy to heavy winter pruning resulted in an increased production of over two bushels per tree in 1926. This was due principally to the fact that a greater percentage of the blossoms set and matured fruit. On the other hand, the influence of the fertilizer applications on size of fruit has been variable. In 1924, a

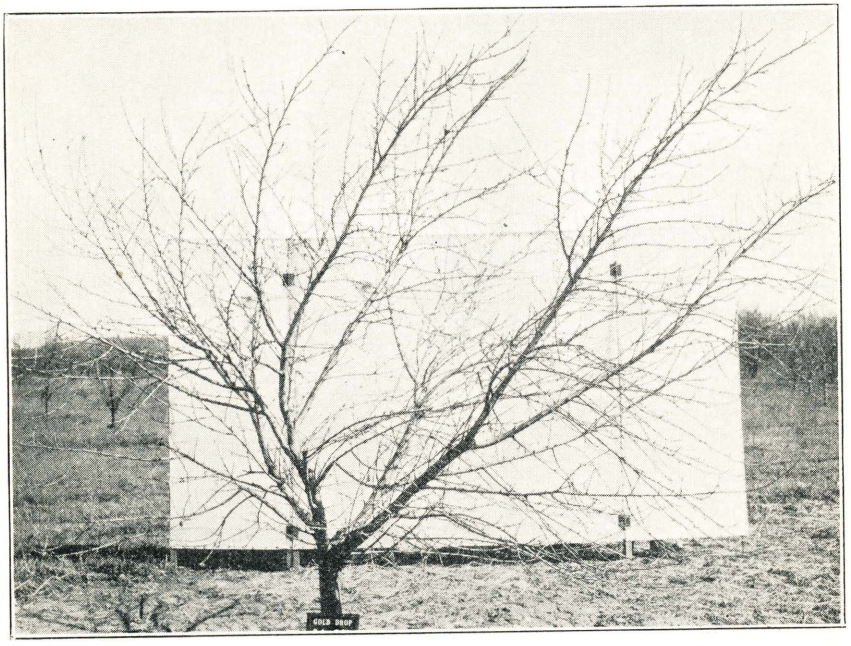

Figure 3.—A typical 6-year old Gold Drop peach tree that has not been pruned for three years. Photo taken in April, 1927.

light crop year, it produced considerable increase in size of fruit in both the unpruned and the pruned trees. In 1925 and 1926, seasons of heavy production, fertilization caused a heavier setting of fruit and a consequent reduction in size, except on the rather heavily pruned trees in 1925, where the pruning itself resulted in a rather heavy thinning and a material reduction in the total crop. At current prices for the different sizes (See Table 2) and an assumed average cost per tree of 10 cents for material and the labor of application, fertilization increased the return from each unpruned tree from $1.59 to $3.09 in 1924. The following year a similar investment in fertilizer increased the returns per tree from $5.06 to $5.76 and in 1926 from $3.31 to $3.54. Similarly in the case of the trees which were winter pruned, applications of 10

cents worth of sulphate of ammonia per tree increased the returns in 1924 from $0.36 to $0.64, in 1925 from $1.62 to $3.74 and in 1926 from $2.83 to $4.27. The use of nitrogen-carrying fertilizers has proved profitable in this orchard.

In an orchard of young vigorous Elberta trees located near Berrien Springs and growing on a reasonably fertile clay loam, a fertilizer test in 1926 gave similar, though less pronounced, results.

The records of these and other experiments and the results of many growers' experience with nitrogenous fertilizers indicate that, as a rule, fertilization of the peach orchard pays. Generally, fertilizer applications yield larger dividends on the lighter soils and with old trees than with more vigorous trees.

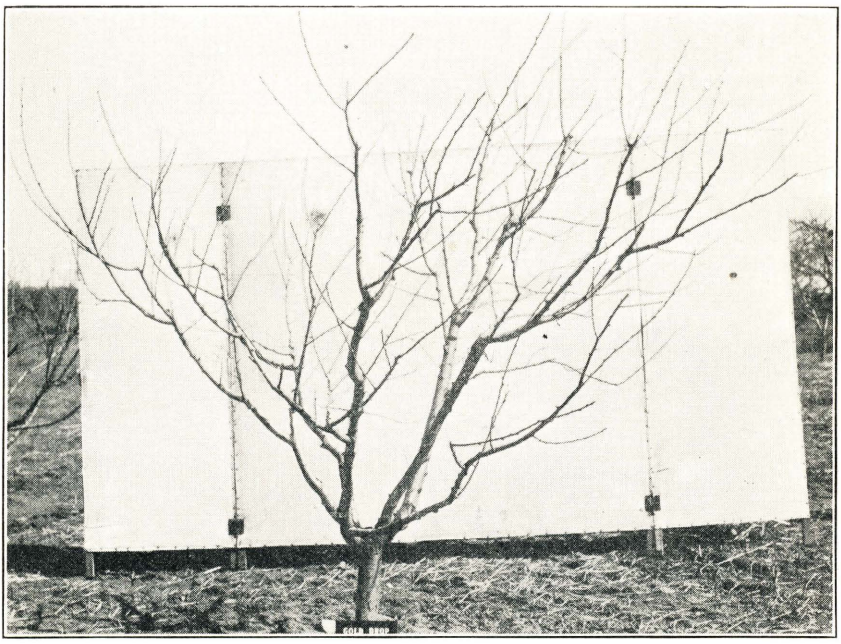

Figure 4.—A typical 6-year old Gold Drop peach tree that has had a moderate dormant season thinning out and heading back, combined with some thinning out of the shoots in early summer. Photo taken in April, 1927.

Pruning

The peach is the one tree fruit that growers generally agree should be pruned annually. Furthermore, it is generally agreed that, as compared with other tree fruits, it should be pruned comparatively severely. There is, however, much difference of opinion as to what constitutes severe pruning, and pruning practice varies greatly both in kind and amount.

Experiment with Kalamazoo Trees

Shoot Growth, Fruit Bud Formation, and Winterkilling of Fruit Buds —Six of the 10 plots in the Corporation orchard near South Haven were given each year what would generally be considered a fairly heavy winter pruning though it was not so severe as is sometimes employed. Some measure of its severity is afforded by the statement that an actual count showed that the pruning removed 24,925 fruit buds from a tree selected as typical of Plot 3 and the fruit buds which

Figure 5.—A typical 6-year old Gold Drop peach tree that has had a moderate amount of dormant season thinning each year, but no heading back. Photo taken in April, 1927.

remained on the tree were estimated at 10,000. This pruning resulted in a considerable thinning out of the smaller branches and in a rather general heading back of the shoot growth that remained. Most of the work was done with hand shears and would be classed as a rather "detailed" type of pruning, probably involving a greater expenditure of time than the average grower would consider practicable. It nevertheless served to test the several influences of moderate to severe pruning.

Data on the influence of pruning on shoot length, on the average

number of fruit buds per shoot, and on the winterkilling of buds are presented in Table 4. It will be noted that the pruning that was afforded resulted in practically doubling the average shoot length and the average number of buds per shoot, though probably there was a

Table 5.—The influence of fertilizer applications on yield, size, and cash value of fruit. Sixteen-year-old Kalamazoo peach trees

	Average yield per tree in bushels	Portion of crop over 2¼ inches in diameter		Portion of crop 2-2¼ inches in diameter		Portion of crop 1¾-2 inches in diameter		Portion of crop less than 1¾ inches in diameter		Market value
		Bushel	Percent	Bushel	Percent	Bushel	Percent	Bushel	Percent	
1924										
Check trees—no treatment..	1.1	.....	4	.4	33	.5	48	.2	15	$1.67
Fertilized—no pruning.....	2.0	.2	10	.9	44	.8	40	.1	6	3.37
Winter pruned only.....	0.2	.1	28	.1	50	.....	18	.....	4	.38
Fertilized and winter pruned.	0.4	.2	38	.2	46	.1	14	.....	2	.75
1925										
Check trees—no treatment..	5.0	.....	8	1.2	23	2.5	49	.4	20	4.23
Fertilized—no pruning.....	6.4	.1	2	.8	13	3.2	50	2.2	35	4.64
Winter pruned only.....	1.3	.3	23	.6	47	.3	25	.1	5	1.68
Fertilized and winter pruned.	2.9	.8	28	1.4	47	.6	21	.1	4	3.25
1926										
Check trees—no treatment..	4.8	.7	14	1.7	35	1.8	38	.6	13	3.53
Fertilized—no pruning.....	5.7	.2	3	2.0	35	2.5	43	1.1	19	3.76
Winter pruning only.....	3.3	1.4	42	1.3	38	.6	17	.1	3	3.00
Fertilized and winterpruned.	5.6	1.1	20	2.1	38	2.0	35	.4	7	4.34

much smaller influence on the total amount of shoot growth and the total number of fruit buds because the pruned trees produced fewer shoots. The figures on bud killing are inconclusive, though they suggest that possibly the fruit buds on the longer shoots of the pruned trees may be somewhat more susceptible to injury than those on the shorter shoots. The records on shoot growth and fruit bud formation and the appearance of the trees themselves indicate clearly that pruning is of doubtful benefit from the standpoint of increasing bearing surface. On the other hand, it is a means of effecting a change in the character and distribution of the bearing wood as it has the general effect of making the bearing wood more vigorous and bringing the wood closer to the center of the tree. The importance of this latter influence is usually underestimated in the case of the peach, whose wood breaks easily and whose crotches are especially susceptible to splitting.

Detailed records are not available for shoot growth and fruit buds in the several plots of the Elberta and Gold Drop orchards, but observations indicate that the same general statements would apply to them. Some evidence to this effect is afforded by Figures 1 to 12.

Yield and Size of Fruit—Yield and grade records for the old trees in the Kalamazoo block are given in Table 5. In both 1924 and 1925, pruning resulted in a very material reduction in yield, one-half to one-

fourth of the crop borne by corresponding unpruned trees, with some accompanying increase in size. The higher price received for the larger fruit, however, came far short of compensating for the reduction in yield. Indeed the market value of the crop from the average pruned and fertilized tree in 1925 was only $3.25 as compared with $4.64 for the fruit of the corresponding unpruned tree, and, relatively, the differ-

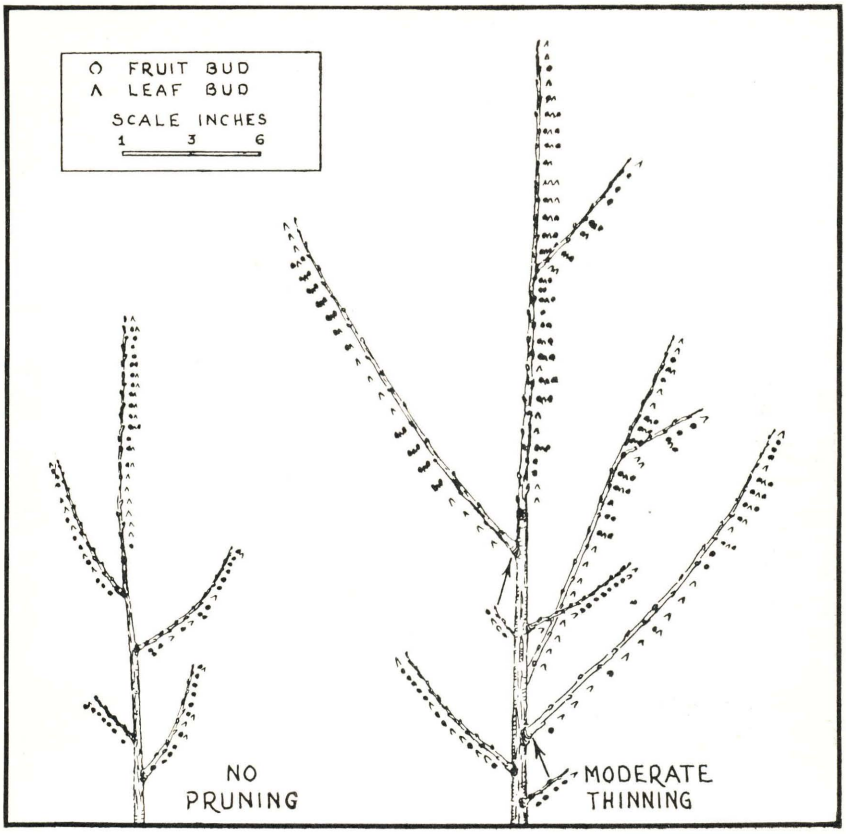

Figure 6.—Characteristic shoot growth when no pruning is given and when the trees are given a moderate thinning. The arrows indicate which shoots would be removed to effect a moderate thinning. Note the number and distribution of the fruit buds on this shoot growth—fruit buds indicated by (●) and leaf buds by (∧).

ences for the unfertilized trees the same year and for both series the preceding year were far greater. On the other hand, in 1926, when a somewhat less severe winter pruning was given, reduction in yield was comparatively small and improvement in grade was almost as marked as before. At 1926 canning factory prices, unfertilized trees which were pruned brought an average return of $3.00, while those that were unpruned brought an average return of $3.53; the pruned fertilized trees

brought a return of $4.34, while the unpruned fertilized trees brought a return of $3.76.

In 1926, young Elberta trees in the orchard near Berrien Springs which were given a similar "detailed" pruning averaged 1.8 bushels apiece, as compared with 3.0 bushels for unpruned trees and approximately 2.5 bushels apiece for those which were pruned somewhat less heavily principally by means of thinning out or by a limited amount of heading back of terminals to strong laterals. Again, in 1927, the "detailed" type of pruning reduced yields below those obtained in trees

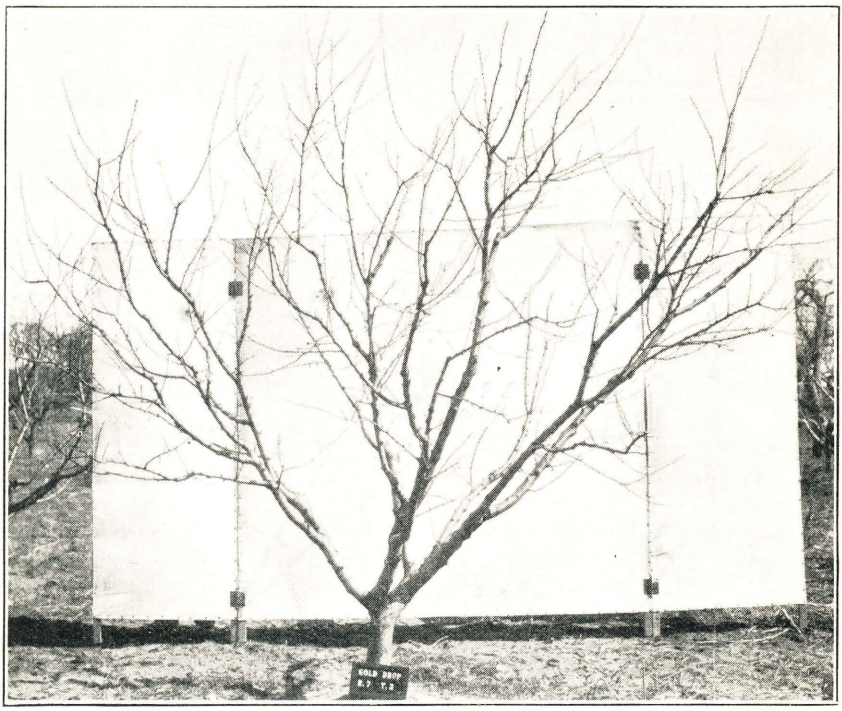

Figure 7.—A typical 6-year old Gold Drop peach tree that has had a moderate dormant season thinning out and heading back, coupled with an early summer pinching of the shoots. Photo taken in April, 1927.

pruned less heavily. Associated with the reduction in total yield was some increase in size of fruit, but not enough to compensate for the lower yield. "Detailed" pruning was no more effective in increasing the size of the fruit than other less expensive methods.

A Trial of Different Pruning Methods With Gold Drop Peaches

A somewhat more extensive comparison of pruning methods was made on trees of the Gold Drop variety at the Graham Station near Grand Rapids. The different methods that were employed are designated and described in the following pages.

A. **Severe Dormant Pruning**—This pruning was a rather severe thinning out, though not more severe than is the practice of some growers, and a 50 to 60 per cent cutting back of the remaining shoots of the previous season's growth. Some idea of the severity of the treatment may be gained from the fact that about 85 per cent of the total leaf and fruit buds were removed in the spring of 1924 and probably nearly an equal proportion in each of the two following years. This does not mean, however, that 85 per cent of the lineal growth was removed, because many of the nodes carried two or three buds. Where

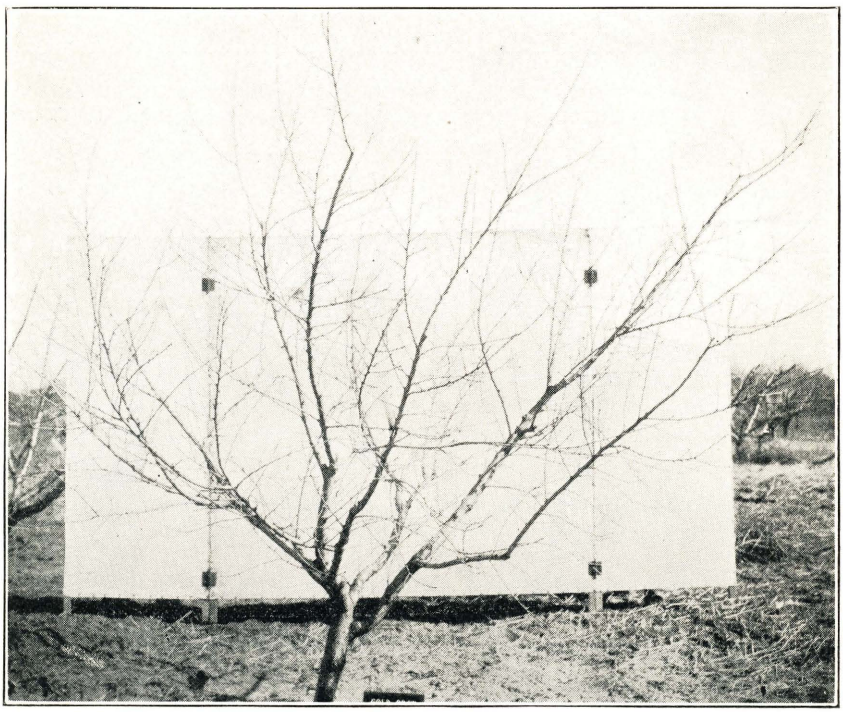

Figure 8.—A typical Gold Drop peach tree that has been given what might be termed a moderate "bulk" pruning each year. Photo taken in April, 1927.

possible, the stronger shoots were headed back to outward-growing laterals and these secondary shoots were then cut back more or less severely. In most cases, unbranched primary shoots were cut back to points just beyond fruit bud bearing sections. A typical tree of this group, after its pruning in the spring of 1927, is shown in Figure 1. Figure 2 shows in greater detail the type of growth response to this method of pruning and likewise indicates the typical resulting distribution of leaf and of fruit buds.

B. **Check**—The trees in this group were not pruned after the spring of 1925. Even the twigs in the interiors of the trees were not removed.

A typical tree of this group, as it appeared in the spring of 1927, is shown in Figure 3 and typical shoot growth is shown in Figure 6.

C. **Moderate Dormant and Summer Thinning**—The trees of Group C were given a dormant pruning similar in kind but less severe than that of Group A and, in addition, some of the summer shoots were thinned out about the middle of June in an effort to encourage the formation of fruit buds along the basal portions of the remaining shoots. Probably, the two pruning treatments resulted in a total pruning as severe as that afforded the trees in Group A. A typical tree of this group, after its pruning in the spring of 1927, is shown in Figure 4.

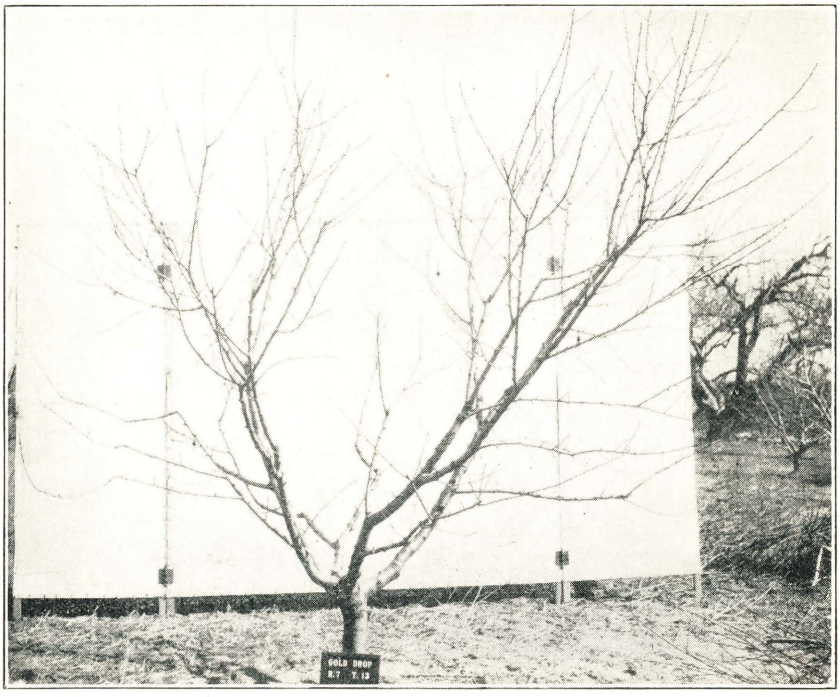

Figure 9.—A typical 6-year old Gold Drop peach tree that has had a light dormant season thinning out and a moderate amount of heading back each year. Photo taken in April, 1927.

D. **Moderate Dormant Thinning**—The trees in this group were thinned as severely as those in Group A but they received no heading back. This kind of pruning resembled what has been termed "long" pruning in some districts. It effected removal of about half of the fruit and leaf buds. A typical tree of this group, after its pruning in the spring of 1927, is shown in Figure 5. The right hand portion of Figure 6 shows in greater detail the type of growth response to this method of pruning and likewise indicates the typical resulting distribution of leaf and of fruit buds.

E. **Moderate Dormant Pruning and Summer Pinching**—The trees in this group received a dormant pruning similar to that accorded the trees in Group C and, in addition, the new shoots were pinched back in the summer when they had made a growth of 10 to 14 inches. The summer pinching of shoots on this group of trees, which resulted in a heavy production of secondaries, made necessary a more severe dormant season thinning out than was required in the non-pinched groups. A typical tree of this group, after its pruning in the spring of 1927, is shown in Figure 7.

F. **Bulk Pruning**—In this group, an attempt was made to reduce the labor to a minimum and still effect a moderate amount of thinning out. This was done by making few but large pruning cuts, cuts for the most part limited to two, three, and four-year-old wood. About a third of the total number of buds were removed by this pruning. A typical tree of this group, after its pruning in the spring of 1927, is shown in Figure 8.

G. **Light Pruning**—This pruning consisted in light thinning out of shoots and a moderate heading back of those which remained, probably effecting about as heavy a pruning as the bulk pruning just described, but distributing it throughout the tree much as in the trees of Group A. A typical tree of this group, after its pruning in the spring of 1927, is shown in Figure 9.

Some measure of the distribution of the pruning cuts through the trees, the severity of the pruning and of the length of time required for the work is afforded by the data presented in Tables 6 and 7, which show the average number of pruning cuts per tree and the average weight of prunings for the years 1924-1927.

Effect of Pruning Treatments on Size of Tree—Experimental work with the apple indicates that pruning has a very decided checking in-

Table 6.—Average number of pruning cuts per tree

Treatment	1924	1925	1926	1927
A. Severe dormant	145	255	645	299
B. Unpruned	0	0	0	0
C. Moderate dormant and summer thinning	122	162	363	184
D. Moderate dormant thinning	104	210	289	216
E. Moderate dormant and summer pinching	89	273	504	247
F. Bulk pruning	23	28	18	46
G. Light dormant	79	210	294	170

Table 7.—Average weights of prunings in pounds per tree

Treatment	1924	1925	1926	1927
A. Severe dormant	4.2	10.2	10.7	11.5
B. Unpruned	0	0	0	0
C. Moderate dormant and summer thinning	3.4	8.7	9.2	8.2
D. Moderate dormant thinning	2.2	7.6	7.0	7.2
E. Moderate dormant and summer pinching	2.8	7.2	10.0	7.9
F. Bulk pruning	2.6	6.8	6.5	6.0
G. Light dormant	1.4	5.6	6.0	8.2

fluence on the growth of the tree. Trees that are pruned heavily for three or four successive years during their early life may not be more than a half or two-thirds as large as those pruned lightly or receiving no pruning. This influence was not evident in these groups of Gold Drop peaches. Both their general appearance (See Figures 1 to 12) and their trunk circumference measurements indicate an increase in size as a result of pruning. Probably, this is to be explained by the correlated differences in their production of fruit. That is, the heavier yields of the lightly pruned and the unpruned trees had as great a checking influence as the heavier pruning in some of the plots.

Yields, Grades, and Returns—Only a few scattering peaches were produced in this orchard in 1924, the fourth season after planting and the season following the initiation of the several pruning treatments. Furthermore, most of the fruit buds were killed during the winter of 1924-1925 and only a light crop was borne in 1925. The crop of that year, however, showed effects of the pruning treatments in both yield and grade (See Table 8). All the pruning treatments materially reduced yields, the heaviest pruning effecting the greatest reduction. Except for the bulk pruning there was an accompanying increase in size of fruit, but, in no case, was the increase in size great enough to compensate in more than a small way for the reduction in quantity. In general, the average size of the fruit was proportional to the severity of the pruning treatment and calculated gross returns per tree would rank the plots in order of their total production per tree and per plot.

Table 8.—Yields and grades per tree, 1925

Treatment	Bushels per tree	Peaches per tree	Peaches per bushel	Size grades (percentage)		
				2¼″+	2-2¼″	−2″
A. Severe dormant	.1	31	229	36	39	25
B. Unpruned	2.5	815	318	4	33	63
C. Moderate dormant and summer thinning	.1	26	263	25	47	28
D. Moderate dormant thinning	.6	180	280	20	46	34
E. Moderate dormant and summer pinching	.2	45	289	17	48	35
F. Bulk pruning	1.0	313	316	13	39	48
G. Light dormant	.8	213	282	20	45	35

The winter of 1925-26 and the season of 1926 were favorable for a heavy crop and consequently a real test of the effects of the several pruning treatments on both yield and size of fruit. Data for the 1926 season are presented in Tables 9 and 10. Again, all of the pruning treatments, with the exception of the so-called "long" pruning, resulted in a reduction in yield, though the reductions were relatively smaller than for the preceding year when there had been much winter-killing of fruit buds. As before, the amount of the reduction in yield was proportional to the severity of the pruning. It is a significant fact that "long" pruning, which was simply some thinning out of the preceding season's shoot growth, did not effect a reduction in yield even though the pruning was equally or even more severe than that which involved some heading back (Groups F and G).

In a general way, the influence of pruning on the size of the fruit was again proportional to its severity. It is plain, however, that the removal of a given amount of wood by means of heading back was much more effective in increasing size than the removal of a similar amount by means of thinning out. The unthinned fruit on the moderately thinned trees (Group D, thinned by means of pruning) was of practically the same size as that on the unpruned trees; and bulk pruning (Group F), which consisted principally in thinning out, effected but little increase in size.

The net prices used in computing the returns shown in Table 10 are intermediate between the average 1926-1927 net prices paid to the grower by one canning factory and a cooperative fruit packing house located in the same city in western Michigan. Fruit two inches or more in diameter is figured at $1.25 per bushel and that with a 1¾-2 inch diameter is figured at $0.80. Fruit under 1¾ inches in diameter is figured as being practically unsalable and of no value. At these prices, it apparently made little difference whether the trees were pruned or not. Some of the pruning treatments have resulted in slightly increased returns, others in slightly decreased returns, per tree. However, it will be noted that half of the crop borne by the unpruned trees was without commercial value because of the small size of the fruits and the extra cost of its handling is a matter of considerable impor-

Table 9.—Average number of peaches per tree and classification according to size for thinned and unthinned five-year-old Gold Drop trees subjected to different pruning treatments, 1926

Treatment	Number peaches harvested	Percent peaches removed in thinning	Number peaches per bushel	Size grades (percentage)			
				2¼″+	2-2¼″	1¾-2″	−1¾″
A. Severe dormant pruning:							
Fruit unthinned	602		307	11	34	27	28
Fruit thinned	280	47	228	38	41	16	5
Average	423		273	20	37	23	20
B. No pruning:							
Fruit unthinned	1810		457	0	4	37	59
Fruit thinned	1056	60	374	0	8	52	40
Average	1418		432	0	6	44	50
C. Moderate dormant and summer thinning:							
Fruit unthinned	424		300	5	44	36	15
Fruit thinned	362	33	257	32	52	13	3
Average	393		279	18	48	25	9
D. Moderate dormant thinning:							
Fruit unthinned	1559		455	0	3	50	47
Fruit thinned	1411	35	354	3	19	60	18
Average	1474		394	2	12	55	31
E. Moderate dormant and summer pinching:							
Fruit unthinned	397		262	22	55	15	8
Fruit thinned	321	43	245	16	55	22	7
Average	352		253	18	55	19	8
F. Bulk pruning:							
Fruit unthinned	1285		430	0	2	52	46
Fruit thinned	592	57	370	0	13	72	15
Average	869		402	0	6	60	34
G. Light dormant pruning:							
Fruit unthinned	1261		402	0	6	53	41
Fruit thinned	580	55	339	1	24	61	14
Average	807		369	0	15	57	28

Table 10.—Average yields in bushels per tree and average net returns for thinned and unthinned five-year-old Gold Drop trees subjected to different pruning treatments, 1926

Treatment	Yield per tree	Yields according to size grade				Returns per tree
		2¼"+	2-2¼"	1¾-2"	−1¾"	
A. Severe dormant pruning:						
Fruit unthinned	2.0	.3	.8	.5	.4	$1.79
Fruit thinned	1.2	.5	.5	.2	.....	1.44
Average	1.6	.5	.6	.3	.2	1.60
B. No pruning:						
Fruit unthinned	4.0	0	.3	1.7	2.0	1.68
Fruit thinned	2.8	0	.3	1.6	.9	1.65
Average	3.3	0	.3	1.6	1.4	1.66
C. Moderate dormant and summer thinning:						
Fruit unthinned	1.4	.1	.7	.5	.1	1.38
Fruit thinned	1.4	.6	.7	.1	.....	1.67
Average	1.4	.3	.7	.3	.1	1.54
D. Moderate dormant thinning:						
Fruit unthinned	3.4	.....	.1	1.8	1.5	1.63
Fruit thinned	4.0	.2	.9	2.4	.5	3.23
Average	3.7	.1	.5	2.2	.9	2.54
E. Moderate dormant and summer pinching:						
Fruit unthinned	1.5	.4	.9	.1	.1	1.75
Fruit thinned	1.3	.3	.8	.2	.....	1.48
Average	1.4	.3	.8	.2	.1	1.57
F. Bulk pruning:						
Fruit unthinned	3.0	0	.1	1.6	1.3	1.40
Fruit thinned	1.6	0	.3	1.1	.2	1.25
Average	2.2	0	.2	1.4	.6	1.33
G. Light dormant pruning:						
Fruit unthinned	3.1	0	.2	1.9	1.0	1.80
Fruit thinned	1.7	0	.5	1.0	.2	1.47
Average	2.2	0	.4	1.3	.5	1.58

tance. Furthermore, anyone seeing the trees would say that the pruning treatments were justified from the standpoint of keeping them within reasonable bounds and thereby reducing various production costs.

Summer Pruning

As already stated, summer thinning of shoots was employed on one of the Gold Drop plots and summer pinching on another. Moderate dormant-season thinning out and heading back was combined with both summer thinning and pinching. The general effect of both these treatments was to materially reduce yield without effecting a compensating improvement in size of fruit (see Tables 9 and 10). Similarly, in the Kalamazoo block near South Haven, summer thinning of shoots, which was employed in three different plots, effected a substantial reduction in yield as compared with similar plots not summer pruned and there was only a small accompanying increase in size of fruit. Summer pruning of the peach cannot be recommended on the basis of the results of these tests.

Thinning

Thinning of the fruit is regularly employed by a comparatively large percentage of peach growers as a means of improving grade. Others,

however, are inclined to believe that it does not pay and, among those with whom it is a regular practice, there is much variation in the way the operation is carried out. Thinning experiments were carried out in all three orchards included in this series of experiments. No single rule was rigidly followed in this thinning work, but an attempt was made in the thinned plots to remove enough fruits so that no two remaining would touch each other and in most instances they were thinned so as to be about four or five inches apart. The thinning was done comparatively early in the season to give the fruits which remained the greatest possible opportunity to profit by the removal of their competitors.

Figure 10.—Summer view of a Gold Drop peach tree that has received heavy dormant season heading back and thinning out.

Results that were obtained in 1926 in the Gold Drop block are presented in Tables 9 and 10. In most instances, thinning resulted in a reduction in total yield; in one plot, this reduction amounted to 47 per cent. Where comparatively light thinning was practiced on heavily loaded trees (Blocks C and D), however, there was no reduction in total yield and in one instance a slight increase. Thinning invariably resulted in an increase in the percentage of large fruits and in most instances in an increase in absolute amount of the larger sizes. The data indicate that the amount of the increase in size of fruit is determined by the number of fruits borne by the tree during the later part of the growing season rather than by the percentage of the fruits removed in the process of thinning, because no close relationship is evident between the degree or severity of thinning and the increase in size of

fruits. This statement is supported by the fact that the co-efficient of correlation between the number of fruits on the trees at harvest and the size of the fruit is $-.892 \pm .002$, while that between the percentage of fruits removed at thinning time and the ultimate size of the fruit is only $-.147 \pm .110$. Thus, an unthinned tree carrying 2,000 fruits may be expected to produce fruit of the same average size as one of equal vigor with 4,000 fruits of which half are removed in early summer. The practice of thinning fruits so that certain arbitrary distances exist between those that remain is sound. Fruit thinning resulted in decreased net returns per tree in those instances where total yield was materially reduced, but, where the thinning was less severe and yield remained approximately the same, returns were increased.

Figure 11.—Summer view of a Gold Drop peach tree that has received a moderate dormant season thinning out. This might be termed a "long" system of pruning.

The three years thinning records for the Kalamazoo block near South Haven are presented in Table 11. With this variety, as with Gold Drop at Grand Rapids, thinning of fruit almost invariably resulted in some decrease in total yield, though only what would be called a moderate thinning was practiced. However, the reduction in yield was due principally to a reduction in the number of small sized fruits of little or no value; the number of the larger specimens was often increased. In those instances where the thinning was light enough so that total yield was not greatly decreased and where the amount of fruit of large size was materially increased, the practice proved profitable. In a number of instances it was unprofitable, in spite of the fact that it increased the percentage of large sized specimens. The figures in-

dicate clearly that thinning is an effective means of increasing the average size of peaches but suggest equally clearly the necessity of conservatism in thinning, if the operation is to be profitable.

In the Elberta orchard near Berrien Springs in 1926, fertilized and moderately pruned but unthinned trees averaged 2.8 bushel each and it required an average of 189 peaches to make a bushel. Corresponding trees whose fruit was moderately thinned averaged 2.4 bushels each and it required 169 to make a bushel. In 1927, the same group of trees averaged 4.3 and 3.5 bushels, respectively. The thinned fruit sold at a premium of $0.30 per bushel in 1926, just compensating the grower for the reduction in yield. In 1927, there was a slightly greater

Figure 12.—Summer view of a Gold Drop peach tree that has received no pruning for the past three years.

difference in price between the two sizes, the general price range was higher, the trees yielded more heavily, and fruit thinning resulted in a net profit of about $0.25 per tree.

In 1925, 13 of a group of 22 five-year-old Marquette peach trees growing on the grounds of the Graham Horticultural Experiment Station near Grand Rapids were thinned. They yielded 72.2 pounds of fruit each and it required 114 peaches to make a bushel; the nine unthinned trees averaged 115.2 pounds of fruit and it required 132 to fill a bushel. In this particular instance, thinning proved unprofitable because it resulted in too great a reduction in yield.

In this series of experiments, fruit thinning has invariably resulted in an improvement in grade through increasing the size of the fruit. It has generally, though not always, been followed by somewhat re-

Table II.—Yields and grades of Kalamazoo peaches from thinned and unthinned plots, in pounds

	1924					1925					1926					Average for 3 years				
	Average yield per tree	Average per tree over 2¼"	Average per tree 2-2¼"	Average per tree 1¾-2"	Average per tree under 1¾"	Average yield per tree	Average per tree over 2¼"	Average per tree 2-2¼"	Average per tree 1¾-2"	Average per tree under 1¾"	Average yield per tree	Average per tree over 2¼"	Average per tree 2-2¼"	Average per tree 1¾-2"	Average per tree under 1¾"	Average yield per tree	Average per tree over 2¼"	Average per tree 2-2¼"	Average per tree 1¾-2"	Average per tree under 1¾"
Check	51.5	2.1	17.0	25.3	7.1	223.5	17.9	51.4	109.5	44.7	215.0	30.1	75.2	81.7	28.0	163.3	16.7	47.9	72.2	26.5
Thinned only	38.2	1.8	12.5	20.0	3.9	137.3	3.8	30.9	68.5	34.1	134.0	22.4	62.5	45.3	3.8	103.2	9.4	35.3	44.6	13.9
Winter pruned only	10.2	2.9	5.1	1.7	.5	58.8	13.5	27.7	14.7	2.9	149.2	62.7	56.7	25.3	4.5	72.7	26.4	29.8	10.6	2.6
Winter pruned and thinned	16.0	3.5	9.0	3.0	.5	45.2	16.4	20.1	7.7	1.0	122.0	68.7	41.0	11.7	.6	61.1	29.5	23.4	7.5	0.7
Winter pruned and fertilized	17.1	6.5	7.9	2.4	.3	132.3	37.0	62.2	49.5	5.3	254.0	50.8	96.5	88.9	17.8	134.5	31.4	55.5	36.9	7.7
Winter pruned fertilized and thinned	19.8	10.0	7.9	1.9	.0	133.0	44.5	62.2	22.8	3.5	151.4	70.3	62.9	15.9	2.3	101.4	41.6	44.3	13.6	1.9

duced yields. In many instances, the reduction in yield has been of such magnitude that the higher price received for the larger fruit has failed to compensate the grower for his labor. Thinning has proved profitable only where the crop has been comparatively heavy and the thinning itself has been rather light. It is a practice to recommend to the peach grower but it should be employed conservatively.

Discussion

Although this series of experiments has dealt primarily with three cultural practices, fertilization, pruning, and fruit thinning, the fact that stands out most prominently in all the work is that winter injury to the fruit buds is the limiting factor of first importance in the peach industry in Michigan. Seldom, if ever, does a winter go by when some buds are not winterkilled in the "fruit belt." In most seasons, there is enough bud killing to seriously reduce the crop in some of the commercial sections and with some varieties, and the years when winter cold makes a more or less clean sweep are all too frequent. Against this tax levied by winter cold, the peach grower with an orchard already established is comparatively helpless. The best insurance and the most practicable method of dealing with the problem, is to plant only in locations and on sites which are favored by moderating lake breezes or by exceptionally good air drainage or in locations which are protected in some other way so that winter injury to buds and wood will be reduced to a minimum. Furthermore, the various orchard operations should be planned and carried out with this constant threat of winter injury in mind if the maximum income from the orchard is to be realized. This will probably mean in many cases some deviation from what has come to be standard pruning and thinning practices in some of the other peach raising districts.

The data presented show that any cultural practice which substantially reduces yield also results in lower returns, and, conversely, any practice that increases yields generally increases the returns. The only one of the three orchard practices that has resulted in any substantial increase in yield has been the application of quickly available nitrogen-carrying fertilizers. They resulted in an increase in the length of shoot growth and therefore increased the bearing capacity of the trees. Furthermore, in rather weak trees, such fertilization tended to increase the percentage of blossoms which set fruit. Only in years of light crops did fertilization result in increased size of fruit. For each dollar expended in applying fertilizer to unpruned trees in one of the orchards, $15.00, $7.00 and $2.30 were returned in the years 1924, 1925, and 1927 respectively; and $2.80, $21.20, and $14.40 resulted for each dollar invested in fertilizer for the pruned trees for these years. Increase in yields in orchards already established must be obtained principally through control of the soil fertility. For this purpose, it is recommended that three to five pounds of sulphate of ammonia, nitrate of soda, or nitrate of calcium per tree be broadcasted in orchards of mature age before the trees blossom.

Pruning does not increase the bearing surface of the tree, but it makes the fruit bearing wood more vigorous and brings it closer to the head of the tree. It also increases the size of the fruit where some

heading back is practiced and where the pruning is well distributed throughout the tree. This increase in size, however, often does not compensate for the lower yields, which means that pruning generally results in decreased returns if the treatment is severe. Some pruning is justified from the standpoint of keeping the tree in bounds, reducing the production costs, maintaining the general vigor of the tree, and reducing the quantity of unmerchantable fruit.

The results of this series of experiments and of numerous observations indicate that for Michigan conditions the best system of pruning for the peach consists in a light to moderate annual thinning out of the new growth (See Figure 11). This is essentially a "long" type of pruning. This type of pruning will give little increase in size of fruit but it will result in higher yields than will a combination of thinning out and heading back. A moderate amount of fruit thinning is desirable if there has been little or no winterkilling of fruit buds. If there has been a considerable amount of bud killing (50 to 75 per cent), the pruning should be light or it will result in a material reduction in yield and returns. If there has been more or less complete bud killing, the trees should be headed back severely (See Figure 10) for the purpose of renewal of the fruiting wood, although this will be necessary only once in three to six years.

Thinning resulted in an increase in the percentage of large fruits, and, in some cases, there was an increase in the quantity of first grade peaches. On the other hand, it reduced the yield except where the trees were heavily loaded and only light thinning was practiced. Where the thinning was not severe enough to materially reduce the yield, the returns were greater than from unthinned trees. Thinning has its place in the Michigan peach orchard but it should be employed only when and where the tree is obviously overloaded. The evidence indicates that, while many Michigan growers do not do enough thinning, some growers thin too severely. The fruits should be thinned so as not to touch each other, but when they are thinned so that those remaining are more than three inches apart the chances are that yield will be reduced to an extent that is not compensated for by increased size.

Summary

1. The records show that only one-half to two-thirds of the Michigan commercial peach crop meets the A-grade specification for size (minimum diameter of two inches).

2. There is an average difference in price of $0.40 to $0.50 per bushel between 2-inch and 1¾-inch (A-and B-grade sizes) peaches and corresponding differences between peaches of other sizes.

3. Applications of quickly available nitrogen-carrying fertilizers have the general effect of increasing yield through increasing the amount of fruit bearing surface and leading to better setting at blossoming time. Whether these fertilizers may or may not result in larger size of fruit depends largely on their influence on fruit setting.

4. Pruning of any kind, but particularly heading back, leads to an increase in the size of the fruit. The amount of the influence depends on the severity of the pruning. At the same time, unless there is a

heavy setting of fruit, pruning usually results in some reduction in total yield and often in decreased returns per tree and per acre.

5. Comparatively light annual pruning of the "long" type is recommended for the peach in Michigan. This should be supplemented by a rather severe heading back or renewal pruning once in every four or six years to obtain new and better placed fruiting wood. For this renewal pruning, advantage can be taken of seasons when there has been more or less complete winterkilling of fruit buds.

6. Light to moderate thinning of fruit results in increased size and greater returns per tree when the trees have set a heavy crop.