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Maintaining the Productivity of Cherry Trees

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During the past several decades, the cherry industry of Michigan has been gradually increasing in size and importance. The eleventh U. S. census report (1890) credits the state with having 447,334 trees of bearing age and of ranking fourth in total acreage. Ten years later the number of bearing trees had doubled, but the state still held fourth rank in acreage. By 1920, however, the number had increased to 1,077,000 and Michigan held first rank in number of bearing cherry trees. More recent data on tree number are not available but observation indicates that there has been a steady increase in acreage and yield and there is reason to believe that the state still leads in number of trees. Furthermore, a larger percentage of cherry trees is probably to be found in commercial plantings, as distinguished from home orchards, than is true in the case of any other fruit crop raised in Michigan.

These facts alone would indicate that the cherry has found a congenial environment in Michigan and that, on the whole, cherry production has proved profitable. Doubtless, this statement squares with the facts. Nevertheless, cherry growers are constantly faced with a number of problems, some of which are relatively important or even serious.

The success of the individual cherry enterprise depends on the operator's ability to meet and solve these problems as they arise. Probably most growers, if asked to name their most serious problems or limiting factors, would mention frost injury to blossoms in the spring, summer defoliation by the leaf spot or shot hole fungus disease, and the difficulty in obtaining what they regard as a satisfactory price for their product. There can be no question but that these are factors of great importance in cherry production.

There is another factor, however, that is of equal rank in determining the degree of success which attends the enterprise and that is the matter of yield. Indeed, it may be said that in one sense at least, yield is of paramount importance and that the main reason why spring frosts and the leaf spot disease are so serious is because they reduce yield. These, however, are negative influences which prevent the trees from attaining their actual potential fruitfulness. The ultimate upward limit on crop, with no frost and no leaf spot, is set by factors, such as soil fertility and moisture supply, which operate through the bearing habit of the tree. Profitable cherry growing, then, depends not only on preventing crop losses from frost and disease, but also on encouraging heavy crop production through promoting an optimum development of the tree.

There is no doubt that, in many orchards in Michigan where frosts and leaf spot are not causing serious losses, full possibilities are not being realized. Yield figures per tree or per acre will not, alone, serve as an indication of the most important limiting factors nor show where improvement can be effected. The trees themselves, however, plainly tell the story to any one who will take the trouble to learn to read it. It is therefore desirable that there be a clear conception of the trees' fruiting or bearing habits and how they are influenced by environmental conditions and cultural practices.

How the Cherry Tree Comes Into Bearing

The well grown cherry tree, as it is received from the nursery, either as a one or two-year-old, possesses no flower buds. Some of its buds may be rubbed off and destroyed in handling; some may remain dor-

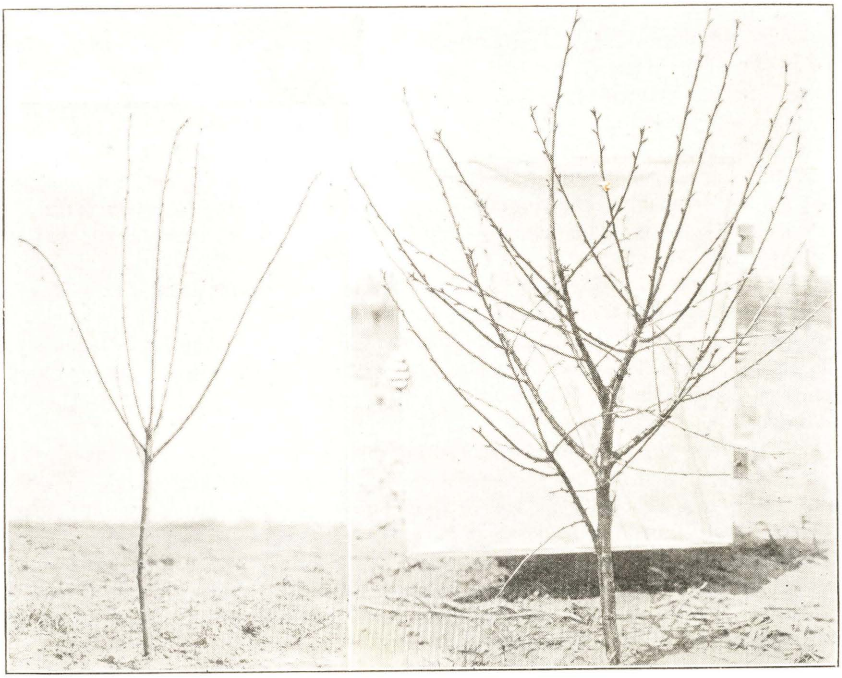

Fig. 1. A Montmorency cherry tree, planted as a 1-year-old whip and headed to a height of 30 inches, after one year's growth in the orchard. Notice that the six uppermost buds grew out to form shoots, that midway between the ground and the top of the trunk (on the right hand side) two grew out to form fruit spurs and that several buds between these spurs and the top of the tree have remained dormant.

Fig. 2. A Montmorency cherry tree, planted as a 1-year-old whip and headed to a height of about 30 inches, after two years' growth in the orchard. Notice that most of the buds on the first season's shoot growth have grown out to form shoots, a few more have formed spurs and some have remained dormant. Relatively the shoot growth of the second season is about as strong and vigorous as that of the first season in the orchard, perhaps even more vigorous.

mant; and those which open give rise either to short leafy growths, which are in reality spurs, or to comparatively long growths, the shoots. Generally, most of the growths the first year are of this latter type and the well-grown one-year-old orchard tree is practically without spurs (Figure 1). Furthermore, practically all of the buds on these one-year-old trees will be vegetative or leaf buds. Where growing conditions are favorable, the second year most of the buds that open will grow out to form shoots, though probably a few will form spurs (Figure 2). Each succeeding year there is normally some diminution in the average length of the new shoots that are formed and an increase, both absolutely and relatively, in the number of spurs (Figure 3). These growth habits of the young sour cherry tree are well illustrated in Figures 1-3.

On account of more or less crowding and consequent shading, many of the shoots of young vigorously growing cherry trees are likely to be rather slender and they may be of small value later from the standpoint of producing fruit spurs and fruit. Furthermore, a large percentage of the spurs produced by the tree during its first two, three, or even four seasons in the orchard are likely to be comparatively short and weak because of shading, and they customarily bear but few fruit buds. (Note the type of spur growth produced by the slender shoot shown in Figure 5.) It is not, therefore, until the tree gets to be some five or six years old that it slows down enough in growth rate to produce large numbers of fruit spurs or to form spurs which make vigorous enough growth to form fruit buds freely. The strongest and most vigorous wood seldom supports the strongest spurs. The slowing down of growth takes place entirely naturally at the age indicated and the tree automatically comes into bearing. Indeed, about the only way it could be prevented from coming into fairly heavy bearing at five to seven years of age would be by such severe pruning and soil fertilization that an extremely vigorous vegetative growth would be maintained year after year.

When for any reason the recently planted cherry tree makes only a limited amount of shoot growth any one season, some of the lateral buds on the resulting short shoots may differentiate flower parts and produce flowers and fruit the following spring and summer. Most of the other lateral buds grow out to form spurs that, because of relatively large size and their exposure to light, form a considerable number of fruit buds. The result is that the tree comes into bearing prematurely and the production of fruit, in itself, serves as a further check to vegetative growth, and the tree is dwarfed. This is well illustrated by the tree shown in Figure 4. Severe drought, starvation, injuries to the roots or crown, and winter injury, of the blackheart type, to the top are the most common causes of this dwarfing. Such trees may eventually outgrow their injuries; or, in other instances, they continue to be undersized and unprofitable, though perhaps productive enough for their size. If, within two or three years, they do not show a tendency to make a reasonable amount of new growth and give promise of developing into normal sized trees, they are not likely to yield an income which will pay for the area that they occupy and they should be replaced.

Fig. 3. A Montmorency cherry tree after three years' growth in the orchard. Notice that during the third season relatively more of the buds on the shoot growth of the preceding season formed spurs and relatively fewer formed shoots than was true during the second season in the orchard. The tree is rapidly acquiring a large number of fruit spurs. Notice too that, though the tree is vigorous, the shoot growth of the past season is distinctly shorter than that of the year before.

The Tree's Increase in Size, Bearing Area and Yield

Each year, the tree increases somewhat in size through the production of new shoot growth. It may be slow or rapid, depending on conditions. Coincident with this increase in size, there is usually a period of increased yield. Then a state is reached when further increase in size is not accompanied by correspondingly greater yields; indeed, there may even be a slow decrease in yield as the tree gradually bcomes older and larger.

The reason for this slowing down and subsequent decline in production is to be found in the fact that, though the tree as a whole is slowly becoming larger each year, the new growth is in the form of

Fig. 4. A Montmorency cherry tree, planted as a 2-year-old, after three years' growth in the orchard. For some reason it never grew satisfactorily. It has produced very little shoot growth but a good many fruit spurs and has differentiated many fruit buds. The shrivelled cherries still hanging to the branches are mute evidence of its premature bearing. Compare with Figure 3 showing a more normal tree of the same age growing in the same orchard.

very short spur-like shoots, and, in a coincident slight growth of the spurs, few or no new spurs being formed. Indeed, there is a gradual decrease in bearing area because new shoot growth and new spur formation are not great enough to replace losses from breakage and the natural dying out of some of the older and weaker fruiting wood in the shaded parts of the tree. Height and spread alone may be deceptive indices of size; it is the total amount of practically potential fruiting wood that sets the upper limit of fruitfulness. All of these almost automatically increase concurrently while the tree is young, until shading and fruiting destroy spurs faster than they are made.

Table 1.—The fruit bud, fruit spur and lateral shoot production of Montmorency shoots of different lengths. The figures are averages for approximately equal numbers of 1919, 1920, and 1921 shoots.

Length in inches	Number shoots averaged	Average number lateral fruit buds	Average number fruit spurs formed subsequently	Average number lateral shoots formed subsequently
0– 1	181	5.7	0.1	0.0
1– 2	117	6.5	0.1	0.1
2– 3	119	7.9	0.3	0.1
3– 4	170	8.9	0.3	0.1
4– 5	163	9.1	0.4	0.2
5– 6	178	9.4	0.5	0.3
6– 7	151	9.0	1.3	0.7
7– 8	124	8.6	1.6	1.1
8– 9	88	7.7	2.6	1.4
9–10	72	7.5	3.0	2.0
10–11	64	6.5	4.1	2.0
11–12	16	8.8	3.0	1.3
12–13	12	5.1	6.0	2.3
13–14	20	5.0	4.2	3.7
14–18	4	3.5	5.2	5.5

Table 2.—The fruit bud, fruit spur and lateral shoot production of English Morello shoots of different lengths. The figures are averages for approximately equal numbers of 1919, 1920 and 1921 shoots.

Length in inches	Number shoots averaged	Average number lateral fruit buds	Average number fruit spurs formed subsequently	Average number lateral shoots formed subsequently
0– 1	21	4.0	0.0	0.0
1– 2	117	6.0	0.0	0.1
2– 3	231	6.9	0.1	0.1
3– 4	262	8.0	0.1	0.0
4– 5	237	9.0	0.1	0.2
5– 6	219	9.9	0.2	0.3
6– 7	138	10.6	0.2	0.6
7– 8	84	10.6	0.1	1.0
8– 9	49	11.0	0.5	1.9
9–10	35	10.4	0.8	2.6
10–12	31	8.7	1.1	4.3
13–28	35	5.5	2.6	6.7

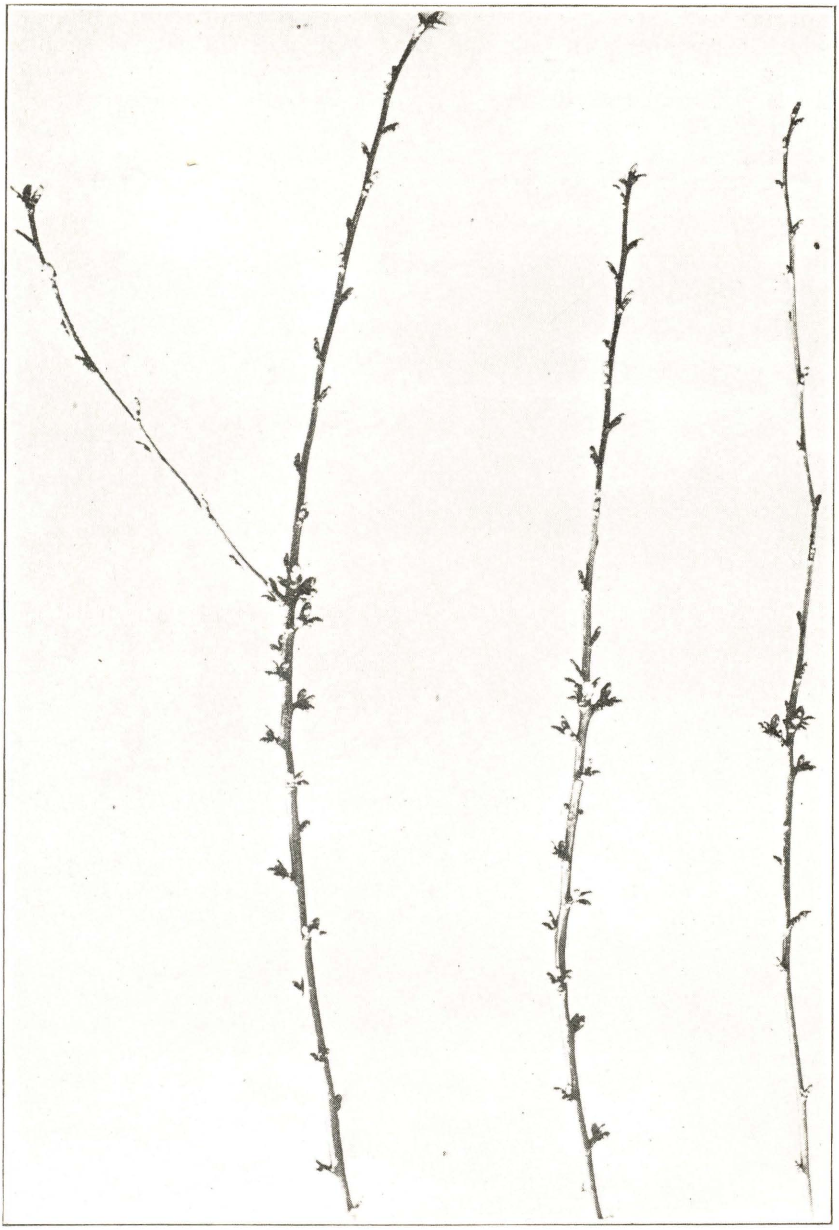

Fig. 5. Comparatively thick, medium, and slender Montmorency shoots and two-yead-old growths of approximately the same length. Note the difference in size of buds on these different-sized shoots. Note also that most of the spurs produced from the lateral leaf buds of the slender growth are short and slender and that they have failed to form fruit buds. The spurs of the stocky growth are larger and have formed fruit buds freely.

Specific data bearing on the question are presented in Tables 1 and 2 which show the fruit bud, the fruit spur, and the lateral shoot production of Montmorency and English Morello shoots of different lengths. It will be observed that both varieties produce lateral fruit buds freely on shoots up to 18 inches in length. However, a larger percentage of the lateral buds are fruit buds in the case of the English Morello than is true in Montmorency. From the standpoint of this

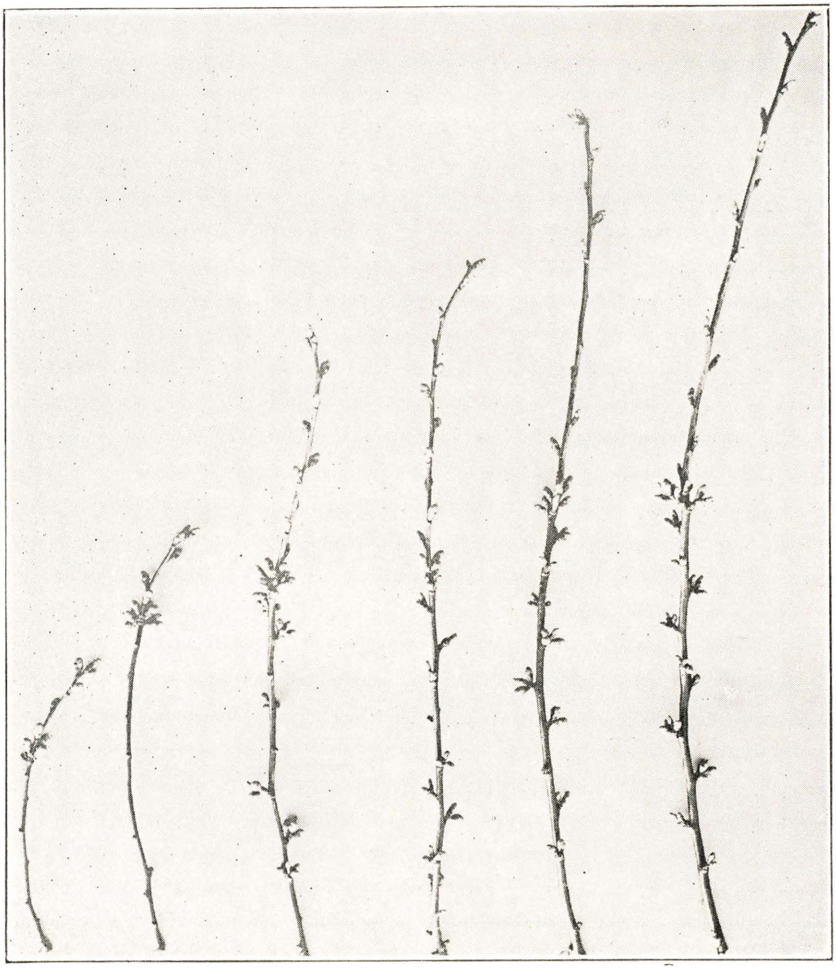

Fig. 6. Shoots and two-year-old growths of the Montmorency cherry of varying lengths. Note that the longest shoot has formed leaf buds only and that strong stocky fruit spurs have grown out from the two-year-old wood of the same type. By way of contrast, the shortest shoot has formed fruit buds only and the preceding year's growth of the same type shows only the scars left by subsequent flowering and fruiting from its blossom buds. The shoots of intermediate length show varying combinations of the characteristics presented by the long and short growths.

lateral fruit-bud formation, shoot growth four to eight or ten inches long is most satisfactory. That is, such shoots produce the maximum number of fruit buds, though not so many per inch as the shorter shoots, see Figures 5 and 6. These statements hold for both varieties. The longer shoots of both varieties are fairly prone to produce lateral shoots from leaf buds. This tendency, however, is more pronounced in the English Morello. The longer the growth of any particular shoot the greater is its number of lateral buds that will grow out into shoots. As a matter of fact, it is only those shoots which are seven, eight, or

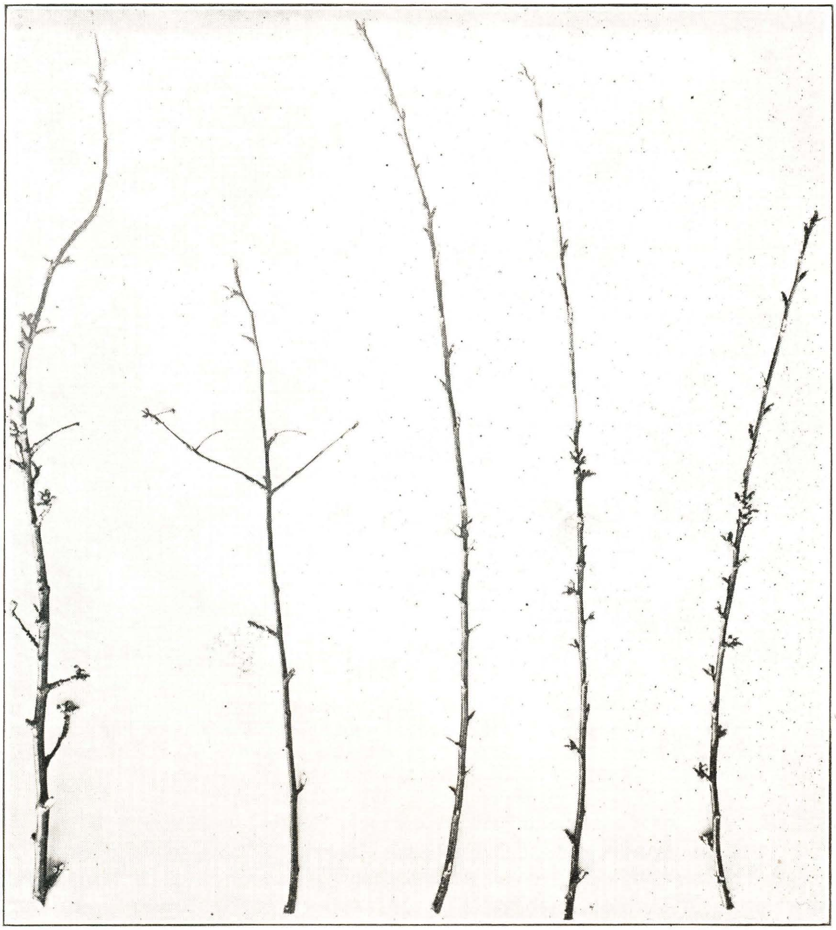

Fig. 7. The shoot on the right, was from a well-sprayed tree in which leaf spot has been thoroughly controlled. The one next to it was from a tree where there was only fair control of leaf spot. The one in the center is from an unsprayed tree defoliated comparatively early in the season by leaf spot. Note the difference in the number of fruit buds formed on the spurs. The small fruiting limb on the left was from a well-sprayed tree. The one adjoining it was from one defoliated prematurely by leaf spot. Note the difference in the condition of the fruit spurs.

more inches long that average one or more laterals apiece. Montmorency, however, is a much better spur producer than is the English Morello, but in the Montmorency shoots must be six inches long or longer if they are to average one or more new shoots apiece.

The figures would seem to indicate that trees whose shoots average from four to six inches in length each year will probably be able to maintain the yields that they have attained up to the time that the annual growth declined to that amount, for there is no material change in the number of fruit spurs produced each year, except as there is a

Fig. 8. A nine-year-old Montmorency tree, grown under a clean-culture cover-crop system of soil management, that the preceding season bore 3,951 cherries (32.5 pounds) on shoots and 7,193 (51.0 pounds) on spurs. Compare with Figure 9.

limited loss of bearing wood through breaking and dying out. If, however, the new shoots average less than four inches in length, the bearing area is reduced, there are correspondingly fewer fruit buds differentiated each year, and yields gradually decline. Increased yields can come only through an increase in the number of fruit buds and this means an increase in bearing wood. This can be brought about through the production of new side shoots from lateral leaf buds and through the formation of new fruit spurs, the former principally in the case of the English Morello, and the latter in the case of the Montmorency. In both varieties, this increase in bearing surface is conditional upon the production of new shoots averaging eight or ten inches long, and shoot growth 10 or 18 inches in length must be produced if there is to be a rapid increase in bearing surface and productivity.

When the orchard reaches the stage where average yields seem to be about as high as can be expected, there is no necessity of so handling the orchard that comparatively long shoots are produced. An average shoot length of six to eight inches is adequate.

In brief, the growing and bearing habits of the cherry are such that:

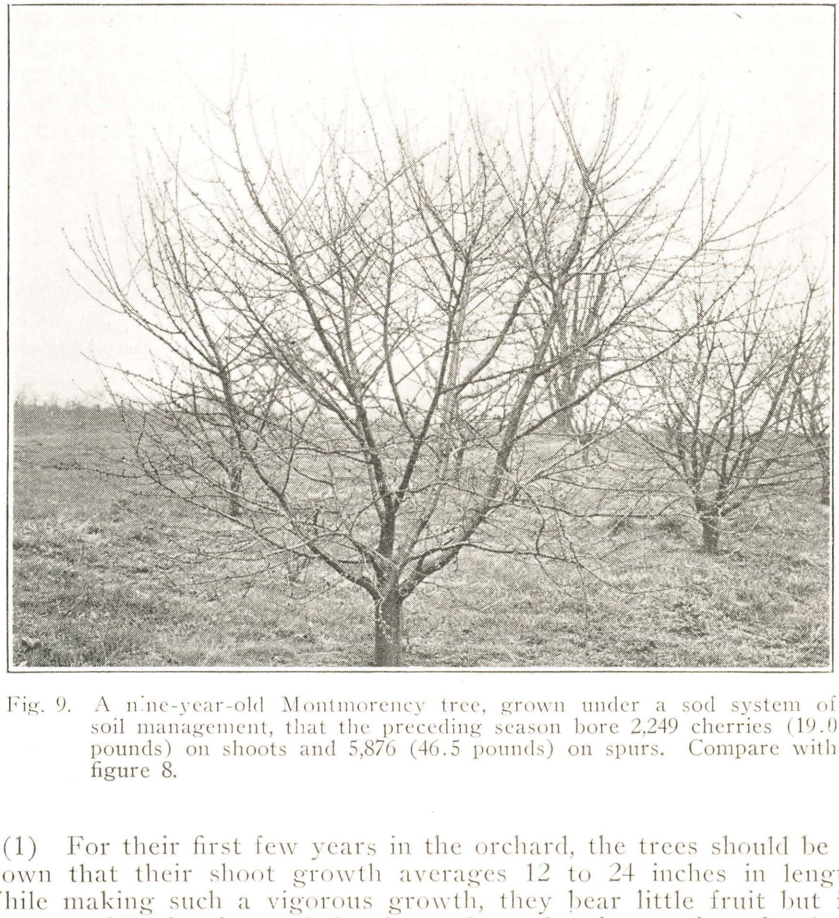

Fig. 9. A nine-year-old Montmorency tree, grown under a sod system of soil management, that the preceding season bore 2,249 cherries (19.0 pounds) on shoots and 5,876 (46.5 pounds) on spurs. Compare with figure 8.

(1) For their first few years in the orchard, the trees should be so grown that their shoot growth averages 12 to 24 inches in length. While making such a vigorous growth, they bear little fruit but increase rapidly in size and develop a large bearing surface for later production.

(2) Then, until they attain full size, they should be so grown that their shoot growth averages six to 12 inches in length. While making growth of this type, they bear heavily and gradually increase in productivity.

(3) After attaining full size and productivity, they should be so grown that their shoot growth averages four to eight inches in length. This will provide for a practically indefinite maintenance of yields.

SHOOT BEARING VERSUS SPUR BEARING

During recent years, there has been considerable discussion as to whether it is preferable to have cherry trees bear the bulk of their crop on shoots or on spurs. The idea has been expressed that heaviest production is always associated with spur rather than shoot bearing, especially in varieties like Montmorency which are naturally inclined to form spurs freely and to bear a considerable portion of their crop in that way. Obviously, it would be impossible to obtain the entire crop from spurs unless an annual pruning away of most of the shoot growth were practiced. This is a procedure, however, that is advocated and more or less followed by some. A more common procedure, however, is simply to encourage a maximum fruit spur formation by promoting a vigorous shoot growth and then do a moderate amount of shoot thinning. If no pruning, or only light pruning, is practiced there will always be a substantial portion of the crop borne on shoots, even in Montmorency. Evidence on this question is supplied by the data in Table 3. The more vigorous, cultivated trees, Figure 8, at the Graham Station produced more fruits on spurs than those grown more slowly in sod lands, Figure 9; but they likewise produced more on shoots. Indeed, 45 per cent of the total crop of the more vigorous trees was borne on shoots, while only 35 per cent of that of the weaker trees was shoot-borne. The greater yield of the more vigorous cultivated trees was due even more to their greater shoot growth than to their larger number of fruit spurs. This, however, is exactly what one would expect from a careful study of the figures in the last two columns of Table 1, for, if the new lateral shoot growth is not pruned away season after season, the net increase in number of fruit buds for any one limb or for the tree as a whole will be as great or greater through the production of the new wood, the shoots, as through the production of new spurs. It is only by means of pruning out the shoot growth year

Table 3.—The 1928 fruiting records of four 9-year-old Montmorency trees, two of which had been grown in alfalfa sod and were rather small for their age and two of which had been under cultivation system of management and were fairly large for their age.

Cultural treatment	Tree No.	Shoot-borne fruits		Spur-borne fruits	
		Number	Weight, pounds	Number	Weight, pounds
Sod grown	1	3,029	23.5	3,221	33.25
Sod grown	2	2,249	19.0	5,876	46.5
Average		2,639	21.25	4,458	39.87
Cultivated	3	6,728	56.5	6,288	51.0
Cultivated	4	3,951	32.5	7,193	61.5
Average		5,339	44.5	6,740	56.25

after year that the Montmorency cherry tree can be made to bear principally on spurs, and then only at the expense of a substantial reduction in the total crop. Still further evidence on this question is supplied by data presented in Table 4 for four trees that were selected as representative of over 100 that were under observation. Five years before these records were taken, these particular trees, then 10 years of age, were making little new growth and were bearing less than 50 pounds of cherries to the tree. Exact records are not available to show what percentage of the fruit was shoot-borne and what percentage spur-borne at that time but later records from trees in the same orchard and in a similar condition indicate that from one-fourth to one-third of the crop was borne on shoots. The 1928 records show that when the trees were three to four times as productive as they were at 10 years of age, largely because of the influence of annual applications of nitrate of soda, approximately 40 per cent of the fruit was shoot-borne. In the case of the two heaviest bearing trees that had not been touched with a pruning tool during the five-year period, one-third of the fruit was shoot-borne while in the case of the two trees that had been pruned lightly each year, the pruning consisting in a removal of small limbs having both spurs and branch shoots, 42 per cent of the cherries were shoot-borne. Very marked increases in yield were in this instance associated with both increased shoot growth and new spur formation and relatively the increase in number of shoot-borne fruits was as great as with the portion of the crop borne on spurs. In brief, the evidence indicates that the grower need give little or no attention to the question of whether the most of his cherries are borne on spurs or on shoots provided the trees are making a reasonably vigorous growth—which, indeed, will insure leaf buds for both new shoot and spur formation. Normally, they will be borne both ways; sometimes more will be borne on spurs; sometimes more on shoots. Cultural treatments, other than pruning, that tend to increase the

Table 4.—The 1928 fruiting records of four 16-year-old Montmorency trees, two of which were pruned lightly each year for several years and two of which had not been pruned for at least five years. All four had received annual applications of nitrate of soda for five years, during which time their yields had tripled.

Pruning treatment	Tree No.	Shoot-borne fruits		Spur-borne fruits	
		Number	Weight, pounds	Number	Weight, pounds
Pruned	1	5,978	57.5	8,300	79.5
Pruned	2	6,326	64.0	9,326	88.5
Average		6,152	60.7	8,813	84.0
Unpruned	3	3,584	31.5	14,165	126.0
Unpruned	4	8,228	79.5	9,466	90.5
Average		5,906	55.5	11,815	108.2

number of spur-borne fruits will at the same time increase the number of those that are borne on shoots.

FACTORS AFFECTING THE BEARING AREA OF SOUR CHERRY TREES

From what has been stated, it is evident that any cultural or other practice which affects shoot length will likewise affect the amount of bearing surface during succeeding years and will thereby influence subsequent yields. It is important therefore that the influence on shoot growth of the several cultural practices and treatments be carefully determined. Among the more important of these factors are method of soil management (sod culture versus clean cultivation), soil type, fertilizer treatment, kind and amount of pruning, premature defoliation by the leaf spot fungus or other causes, and winter injury of the blackheart type.

Sod Culture versus Clean Cultivation For the Sour Cherry

Comparatively few commercial sour cherry orchards are maintained in sod. Here and there, however, a cherry orchard is seeded down to alfalfa and the question is often raised as to whether the practice is advisable.

Data on this question are furnished by the records of a block of Montmorency trees growing on the grounds of the Graham Horticultural Experiment Station near Grand Rapids. The trees were set in the spring of 1920 in a medium heavy but well drained fertile clay loam soil. Half of the area has been kept under a clean cultivation-cover crop system of management. The other half was seeded down the first year to alfalfa and has been kept in alfalfa sod ever since. The alfalfa was cut each year and removed as hay, but each tree in the sod plot had an annual application of a half pound to a pound of nitrate of soda. Growth and fruiting records for these two lots of trees are presented in Tables 5 and 6. It will be noted that from the start the cultivated trees grew more rapidly than those standing in sod, even though the latter received annual applications of nitrogenous fertilizer. At nine years of age, they were nearly twice as large, Figure 10. Though the sod-

Table 5.—Growth records of two lots of Montmorency cherry trees, one maintained in alfalfa sod and the other under a clean cultivation cover crop system of management. Trees set in 1920.

Cultural treatment	Av. trunk circumference in inches		Av. shoot length in inches		Av. number of fruit buds per spur	
	At 4 yrs. of age	At 9 yrs. of age	At 4 yrs. age of	At 9 yrs. of age	At 4 yrs. of age	At 9 yrs. of age
Sod	4.68	13.6	8.4	8.6	3.3	3.1
Cultivated	6.62	16.7	9.2	9.3	2.8	3.2

Table 6.—Fruiting records of two lots of Montmorency cherry trees, one maintained in alfalfa sod and the other under a clean cultivation-cover crop system of management. Trees set in 1920.

Cultural treatment	Average yields, in pounds						
	1923	1924	1925	1926	1927*	1928	Total
Sod	3.91	0.84	6.10	11.40	*	43.08	65.33
Cultivated	0.90	0.52	12.86	18.5	*	79.50	112.26

*Crop failure because of spring frosts.

grown trees bore a few more cherries at four and five years of age than those under cultivation, the latter group forged ahead rapidly and, at nine years, were bearing almost twice as heavily because they were that much larger and had greater bearing surface.

In view of the general experience that alfalfa sod is less detrimental to the orchard than other sods, the deleterious effect of the alfalfa sod here recorded does not invite experiments with sods of other kinds.

Fig. 10. A view looking down between two rows of nine-year-old Montmorency cherry trees at the Graham Horticultural Experiment Station, near Grand Rapids. The row on the left has been maintained under a clean-culture cover-crop system of soil management. The one on the right has been maintained in alfalfa sod. Though the sod-grown trees produced heavier crops at first, the cultivated trees are now outyielding them nearly two to one.

Fertilizers For the Sour Cherry Orchard

When, because of apparent lack of soil fertility or because of very heavy production or perhaps from other causes, trees fail to make as much new growth each year as seems desirable, the application of fertilizers is at once thought of as a remedy for the situation. This is but natural, since numerous experiments with other tree crops have demonstrated the value of fertilizers, especially that of those relatively rich in quickly available nitrogen, in this connection. Few data are available on the use of fertilizers in the cherry orchard, though experiments in Wisconsin (2) and New York (4) indicate that applications of nitrogen-carrying materials are likely to prove valuable. Further data on this question are furnished by the records of a Montmorency cherry orchard located near Mears, Oceana County, Michigan. The soil is a light sandy loam, relatively infertile. The trees, about 10 years old at the time this experiment was begun in the spring of 1923, were small for their age, had been making very little shoot growth and their yields were rather low, averaging a little under 50 pounds per tree. The orchard, however, had been well cultivated and sprayed, leaf spot had been under control, and the trees were healthy. They were not uniform to start with, but, as between the different rows to which different fertilizer applications were made, growth conditions were comparable. The figures in Table 7 show the influence of the several fertilizer treatments on vegetative growth and those in Table 8 on yields.

Table 7.—Influence of fertilizer treatments on vegetative growth of Montmorency cherry trees growing in a light sandy loam in Oceana County, Michigan.

Treatment	Av. 1923 shoot length inches	Av. No. fruit buds per spur formed in 1923	Av. No. fruit buds per spur formed in 1924	Av. 1925 shoot length inches	Percentage of 1924 spurs growing out into shoots in 1925	Av. 1928 shoot length inches	Av. No. fruit buds per spur formed in 1928
Sulphate of ammonia, 2½ lbs. per tree...	5.94	2.66	4.2	4.7	17.8	5.0	4.4
Acid phosphate, 5 lbs. per tree..........	2.86	1.85	3.0	4.6	1.3	†6.7	†4.5
Check—No fertilizer..................	3.18	2.13	3.3	1.9	3.0	†6.7	†4.6
Sulphate of ammonia and acid phosphate.	5.77	3.26	3.7	5.2	15.2	6.0	4.2
Sulphate of ammonia, fall application....	*	1.75	4.0	6.7	41.5	6.2	4.1
Sulphate of ammonia and acid phosphate, fall application......................	*	1.51	4.8	8.3	47.1	5.7	4.5

*No shoot length records were obtained for these two plots in 1923, because no fertilizer was applied to them until the fall of that year. The figures in the next column, however, giving average numbers of fruit buds per spur, indicate rather clearly that to start with these trees were no better than those in the check row.

†Beginning with the spring of 1927 these plots were put under a different soil treatment and therefore their 1928 records are not comparable with their earlier records or with the 1928 records of the other plots.

Table 8.—Influence of fertilizer treatments on yield of Montmorency cherry trees growing in a light sandy loam in Oceana County, Michigan.

Treatment	Av. yield per tree in 1923	Av. yield per tree in 1924	Av. yield per tree in 1925	Av. yield per tree in 1926	Av. yield per tree in 1927	Av. yield per tree in 1928
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Sulphate of ammonia, 2½ lbs. per tree.............	62	73	132	15	....	136
Acid phosphate, 5 lbs. per tree.....................	45	30	80	2	†	†
Check—No fertilizer............................	47	37	74	3	†	†
Sulphate of ammonia and acid phosphate............	62	99	138	29	....	138
Sulphate of ammonia, fall application..............	*	31	109	34	....	151
Sulphate of ammonia and acid phosphate, fall application......................................	*	50	122	43	....	161

*No yield records were obtained for these two plots in 1923, because no fertilizers were applied to them until the fall of that year.

†Beginning with the spring of 1927 these plots were put under a different soil treatment and therefore their 1927-28 records are not comparable with their earlier records or with the 1927-28 records of the other plots.

The results of this fertilizer test are in line with those reported by the Wisconsin (2) and New York (4) experiment stations. The application of nitrogenous fertilizers effected a material increase in shoot length and a slight increase in the number of fruit buds per spur. The effect on old spurs in causing many to grow out to form shoots was fully as striking. All told, the result of the application was to increase greatly the bearing surface of the trees. Acid phosphate had no such influence. Indeed, the trees showed no evidence of any benefits derived from the phosphate.

The yields of the different plots paralleled closely their growth records. It would appear that in 1929 the nitrogen-fertilized trees were still increasing in yielding ability, though possibly the heavy crop of that season was due in part to the fact that in 1927 there was a complete failure because of frost and, consequently, there was opportunity for some recuperation. Obviously, the applications of nitrogenous fertilizer have been profitable. In 1923, approximately 10 cent's worth of fertilizer per tree led to an increase in production of 15 pounds, worth about seventy-five cents on the tree. In 1924, a similar investment gave a return of about $1.30 and in 1925 of $2.90. Even in 1926 when there was a partial failure because of frost, there was a profit of about $0.50 per tree from the use of the sulphate of ammonia. Only in 1927 when crop failure was complete did the grower fail to get back at harvest time the amount invested in fertilizer the preceding spring.

Perhaps the most striking thing about the figures presented in Table 7 is the record made by the trees receiving the sulphate of ammonia applications in the fall, as compared with that of the trees receiving similar applications in the spring. The table does not give the 1923 shoot records of the fall-fertilized trees because no fertilizer was applied to them until the fall of that year. From then on, however, they both outgrew and out-yielded the spring-fertilized trees. Probably, the data are not sufficient to warrant recommending fall instead of spring applications as a general procedure, but they suggest that the grower may well afford to make some trials of his own of this character.

During the course of this fertilizer test, many records, other than those summarized in Tables 7 and 8, were taken. They will not be presented in detail here, but a few statements based on them are in order. The nitrogenous applications did not seem to have any considerable influence on the number of leaves to the spur, but they did result in a distinct increase in the leaves' size, 25 to 35 per cent. Similarly, there was noted some increase in the size of the leaves borne by the shoots, especially those on their median and terminal portions. These influences account, at least in part, for the greater number of fruit buds per spur, already noted, and also for a slightly larger number of flowers per cluster, averaging 2.7 on nitrogen-fertilized trees, as compared with 2.5 on trees not receiving nitrogen.

The general experience in the use of quickly available nitrogenous fertilizers in apple and pear orchards containing rather weak, devitalized trees has been that fruit setting is greatly improved. Similar results might be expected in the case of the cherry, but records taken year after year in the different plots of this orchard show only small differences in fruit setting between the fertilized and the unfertilized trees. It would appear that lack of available nitrogen at blossoming time is not likely to be a factor of major importance in limiting fruit setting of the Montmorency cherry.

Size of individual fruits is not a factor of such great importance with the Montmorency and other cherry varieties grown for the canning trade as it is with those varieties grown for fresh consumption or as it is with most other kinds of fruit, regardless of the way in which they are utilized. Nevertheless, reasonably large size is desirable, if for no other reason than that it makes possible higher yields. Representative samples of fruit from each of the several plots were therefore weighed and the cherries counted, to determine the influence, if any,

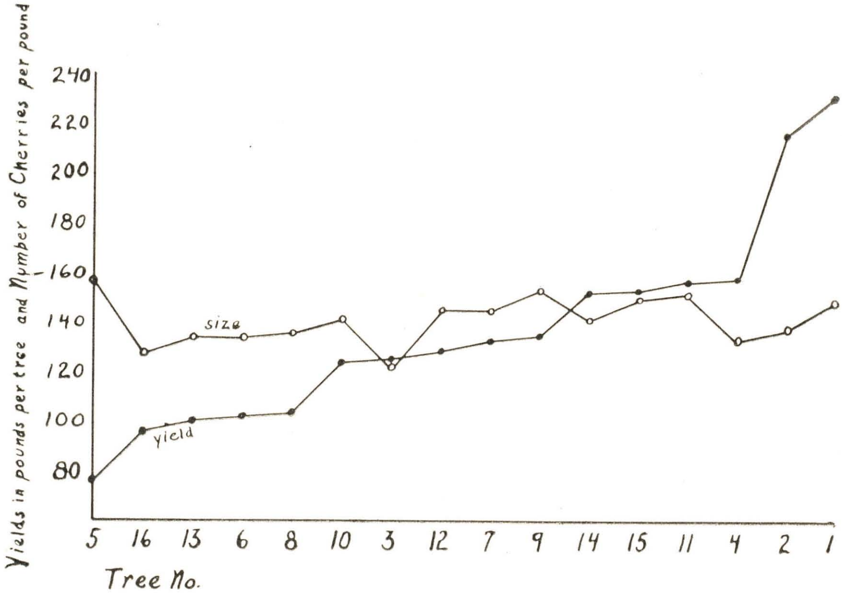

Fig. 11. Graphs showing an apparent lack of correlation between size of fruit and size of crop borne by individual cherry trees.

on fruit size of the different fertilizer treatments. The records show that there was greater variation from season to season than there was between plots the same season. Thus, the average for all plots in 1924 when the season was comparatively wet and the crop moderate, was 89 fruits to the pound. In 1925, when it was comparatively dry and the crop was heavy, the average of all plots was 136 to the pound. During some seasons, the fertilizer applications had no appreciable influence on the size of the fruit. This was true in 1923, 1924, and 1926. In 1925, when the crops were large, the cherries on the unfertilized trees averaged only about 85 per cent as large as those on trees receiving nitrogen applications in the fall. It was thought that possibly there might be some correlation, either positive or negative, between the size of the fruit and the size of the crop borne by the tree.

Data were therefore obtained on the average size of cherry borne by each of the trees under experimental treatment. These records for the group of trees which received a spring application of sulphate of ammonia and acid phosphate are presented graphically in Figure 11. It will be noted that variations in individual tree yield were considerably greater than variations in size of fruit. Furthermore, there is evidently no close correlation between the two. Heavily loaded trees are about as likely to produce large cherries as are those bearing a light crop; conversely, the fruits on light yielding trees may be either large or small.

The Use of Nitrogenous Fertilizers on Trees Weakened by Blackheart

From the statements that have been made, it might be inferred that the application of nitrogenous fertilizers can be expected to result in increased growth and yields whenever trees are weak and non-productive. That they do not always have such an effect was shown by records obtained from a fertilizer trial in a cherry orchard in Grand Traverse County.

This orchard of Montmorency trees was about 15 years old at the time the experiment was begun, in the spring of 1923. The soil was a medium deep sandy to gravelly loam of average fertility. Some of the trees were fairly large for their age; others were medium or below in size. None of them was vigorous, the terminal shoot growth seldom exceeding five or six inches and averaging less than three inches. Many of the trees showed a limited amount of dieback, principally in the small, weak interior limbs. Yields were variable, corresponding more or less closely to size and vigor of tree. For several years, the orchard had been declining rather than increasing in productivity, though it had never attained the yield that normally would be expected from trees of that variety on this particular soil. Nitrogenous fertilizers were naturally thought of as a remedy for the situation. Accordingly, in the spring of 1923, a series of fertilizer trials were begun, using nitrate of soda, sulphate of ammonia, and acid phosphate. The fertilizers were tested alone and in combination. The seasons of 1923 and 1924 were both favorable for vegetative growth and for fruit production. In neither season, however, was there any evidence of greater shoot growth, better setting of the fruit, or larger crops as a result of any of the fertilizer treatments. Some of the check trees were among the most vigorous and most productive. Furthermore, the fertilized trees continued to show as much dieback as those in the untreated plots. At the end of this two-year period, the trees in all of the plots were in a more weakened condition than at its beginning. The situation seemed inexplicable.

At the time the experiment was begun, the trees seemed entirely healthy, though lacking in vigor. When for two successive seasons they failed to respond to nitrogenous fertilizers under conditions where a marked response was expected, it was thought that possibly something might be the matter with the roots. Examination revealed the fact that, though the great majority of the roots were within the surface 12 or 15 inches of soil, many penetrated to a depth of two or three feet and all seemed entirely normal and healthy. Obviously, the unsatisfactory growth of the tops could not be attributed to any defect of the root system.

During the two years that the fertilizer test had been in progress, the trees had not been pruned. Earlier in their life, however, a moderate amount of pruning had been given. Most of the pruning wounds were small. The fact that most of them had not healed over had not been particularly noted, because wounds in cherry trees are often rather slow in healing. When the roots were found to be normal, the tops were subjected to a more careful scrutiny to find, if possible, some clue to the peculiar behavior of the trees. It was observed that some of the pruning wounds had a somewhat ragged appearance, that is, the pruning saw, instead of having made a clean cut with a smooth surface, had left a rough, uneven surface with a tendency toward projecting shreds or fibers.

Examination showed that this wood was soft and more or less spongy, due to invasion by heart-rot fungi. Upon further investigation, it was found that the trunk, main limbs, smaller branches, and even the twigs and fruit spurs were in a blackhearted condition, and that, in many cases, wound-rot fungi had gained entrance and were causing a kind of dry rot. Indeed, there was every indication that year by year this decay was spreading outward, including layers of sapwood from the inside more rapidly than new layers were being deposited on the outside. Apparently, when the surviving layer of sapwood became so thin as to be unable to provide the tissues above with an adequate water supply, dieback followed. That fertilizer applications under these conditions were of little avail is hardly surprising.

Numerous field observations which have been made since the correct diagnosis of the condition that obtained in this particular orchard indicate that a similar situation obtains in many cherry orchards. Winter injury of the blackheart type is very likely to occur any winter of even moderate severity, following a season when there has been extensive premature defoliation occasioned by the leaf spot fungus. The fact that fertilization is not a corrective for lack of vigor due to blackheart emphasizes the importance of measures that will prevent its occurrence.

PRUNING

There is much difference of opinion as to how much and how the sour cherry orchard should be pruned. Some growers prune moderately to heavily and more or less regularly. A much larger number do very little pruning. In this, they may not be following any time-honored precept but they are at least acting on a long accepted opinion that, as compared with most other tree fruits, cherries require only light cutting. The Wisconsin Experiment Station (1) recommends what would generally be classed as moderately heavy to heavy pruning, not from the standpoint of increasing the total amount of bearing wood of all kinds (spur and shoot) but for the purpose of promoting a more vigorous terminal shoot growth and thereby obtaining a larger percentage of spur-borne (as contrasted to shoot-borne) fruit buds.

These spur-borne buds are somewhat hardier than those borne on shoots, a matter of considerable importance in some of the Wisconsin cherry raising districts. This factor, however, is one to which little attention need be paid in Michigan. Experience in this State (3) shows clearly that heavy or even moderate pruning of young cherry trees delays their bearing and greatly reduces the size of their early crops. Only light corrective pruning while they are three to nine or 10 years of age, to aid in shaping the tree, is recommended. As the trees get older, however, their tops gradually become more or less thick and brushy and they certainly appear to require pruning. Pruning experiments with mature Early Richmond, Montmorency, and English Morello trees in New York (4), however, have led to the conclusion that pruning alone is almost certain to result in reduced yields, although, when liberal applications of nitrogenous fertilizers are made to the pruned trees, yields are maintained or even increased.

Only moderate to light pruning was employed with the series of tests reported in this bulletin. Every other tree in a row receiving an annual application of nitrate of soda at the rate of three pounds to the tree was pruned each spring. This pruning consisted principally in a removal of some of the smaller limbs in portions of the tree that had become rather thick and brushy. The 1925-1928 fruiting records of these trees are presented in Table 9. In this instance, the rather light pruning had only a small influence on yields and that was to reduce them. Certainly, the practice has not been profitable. Perhaps the time will come when the tops of the unpruned trees will become so thick and brushy that considerable pruning will be deemed necessary, but it is obvious that these trees that in the spring of 1925 had not been touched with pruning tools for six to eight years were not in great need of pruning, and the 1928 record of those which had remained unpruned for four more growing seasons was such as to raise a serious question as to the advisability of anything more than a light pruning.

Table 9.—The 1925-1928 shoot, fruit spur and fruiting records of 16 mature Montmorency trees set in 1913, half of which were pruned and half unpruned. Pruning treatment begun in the spring of 1925. Average yields given in pounds.

Year	Unpruned	Pruned	Av. 1928 shoot length in inches		Av. No. fruit buds formed per spur in 1928	
			Pruned	Unpruned	Pruned	Unpruned
1923	74	68	....	....	....	....
1924	75	72	....	....	....	....
1925	202	177	....	....	....	....
1926	40	24	....	....	....	....
1927	**	**	....	....	....	....
1928	169	161	6.0	6.3	4.6	4.7

The reason for this conclusion becomes clear when two characteristics of the Montmorency cherry tree are recognized:

1. Montmorency fruit spurs are relatively short lived.
2. Regardless of pruning treatment, the major portion of the crop

is borne within a comparatively thin or shallow rim around the outside of the tree.

A few good fruiting spurs usually are found on four and five-year old wood and occasionally an older wood, but by far the greater number is found on that which is two or three years old. Indeed the most vigorous, most productive spurs are almost invariably found on the two-year-old wood. Apparently, the production of a single crop of fruit more or less weakens them and each succeeding season sees them becoming less and less productive. Furthermore, for some reason, fruit spurs on the strong, more upright, rapidly thickening branches of the sour cherry (such growth is encouraged by relatively heavy pruning) seem to lose their vigor more rapidly and are shorter lived than those that grow on shoots which are less upright in habit and are less vigorous.

From theoretical considerations, it would seem that the pruning should tend to invigorate and lengthen the life of the spurs:

1. Through reducing the total number of spurs and thus providing those that remain a larger nutrient and moisture supply, and
2. Through admitting to them a larger supply of light.

In reality, however, the spurs show just the opposite response and the pruning treatment, or its lack, which leaves a relatively large number of moderately vigorous shoots year after year, not only provides the maximum number of fruit spurs but contributes to their individual and collective efficiency and to their long life. The futility of trying to develop and maintain maximum production by either extensive thinning out of the top or by heading back is well illustrated by the figures presented in Table 10, showing the total number of fruit buds in the outer, the medium, and the interior concentric zones of the tree's top.

Table 10.—Blossom buds on an 18-year-old Montmorency cherry tree, grouped according to their distribution in concentric zones having for their center the crotch of the tree.

Distance in inches of zone from tree crotch..........	0–24	24–48	48–72	72–96	96–120	120–144
Total number of blossom buds in zone..............	2,629	8,615	10,481	17,063	6,860	1,237

Were the spurs of the cherry longer lived, as they are in the apple, pear, or sweet cherry, or were it possible materially to lengthen their life by pruning, a different treatment would be suggested. When, however, both maximum fruit spur formation and maximum efficiency and longevity of spurs are associated with the type of growth that accompanies very light pruning, the burden of proof lies with those who would prune heavily.

It is not the intention here to recommend against all pruning of bearing sour cherry trees. There is always likely to be some shaping of the top, some crossing limbs, and some bad crotches which require attention. However, the evidence that is available suggests that heavy pruning is seldom in place in Michigan cherry orchards and that ordinarily only light pruning is in order.

EFFECTS OF PREMATURE DEFOLIATION

That premature defoliation, because of leaf spot attacks, spray injury, or other cause, checks growth is well recognized. The amount of this check depends on a number of factors, but principally on the earliness and the completeness of the defoliation. Some evidence on this question is afforded by the figures presented in Table 11.

Table 11.—The effect of premature defoliation, occasioned by the leaf spot fungus, on the shoot growth of 16-year-old Montmorency trees.

Year	Orchard No. 1, leaf spot	Average shoot length in inches	Orchard No. 2	Average shoot length in inches
1926	Good control, no defoliation	1.8	Poor control, early defoliation	1.4
1927	Good control, no defoliation	4.1	Poor control, early defoliation	3.1
1928	Good control, no defoliation	4.2	Good control, no defoliation	4.2

Note: In 1926, shoot growth was short, owing to the bearing of a heavy crop and to a limited rainfall. There was a crop failure in 1927, because of late spring frosts, and trees consequently made more vegetative growth.

The two orchards in question were 15 years old in the spring of 1926. They were growing on the same kind of soil, and had been given similar care up to that time and were comparable in every way. Orchard number 1 was sprayed in such a manner in 1926 and 1927 as to afford satisfactory commercial control of leaf spot. In orchard number 2, there was not good control of the disease and the trees lost practically all of their foliage before September 1 each year. In 1928, both orchards were well sprayed. Shoot growth in 1926 was short in both orchards because of heavy cropping and limited rainfall but the shoot growth of the undefoliated trees averaged distinctly better than that of those losing their leaves prematurely. In 1927, there was a crop failure due to frost and the trees in both orchards made a much better vegetative growth than the year before. The defoliated trees, however, made only three-fourths as much growth as the others. That the difference in shoot growth was due to leaf spot attack is indicated by the fact that both orchards averaged about the same amount of new shoot growth in 1928, when the disease was satisfactorily controlled in both of them through spraying. Additional evidence on this question is furnished by records obtained on a group of trees at Graham Experiment Station, near Grand Rapids. One group of trees comparable in every way to the cultivated trees whose shoot growth records are given in Table 5, was not sprayed in 1928. The average new shoot length of these trees that season was 7.1 inches, instead of 9.3.

Great as is its influence on the amount of new shoot growth, premature defoliation has an even greater effect on the functioning and longevity of fruit spurs. This is well illustrated in Figure 7. It will be noted that many of the spurs on the older defoliated branch have died, while those of the same age on the branch that held its foliage are alive and have formed fruit buds freely. None of the spurs on the most severely defoliated young branch has formed fruit buds, and the branch next to it where there was only partial control of the disease has formed only about half as many as it should. It is thus evident that the effect of premature defoliation on fruit bud formation is much more pronounced than is that of an inadequate nutrient supply and probably for that reason leaf spot control can be said to assume the place of first importance in determining yield.

DISCUSSION

In brief, it may be said that the growing and bearing habits of the sour cherry tree are such that normally the tree comes into moderately heavy bearing without requiring much, if any, special attention on the part of the grower to hasten or delay the process. If growth of the young trees is extremely vigorous, measures should be taken to retard it somewhat during the four to six year period. If, on the other hand, growth is somewhat weak and the tree shows a tendency to come into bearing prematurely, measures should be taken to invigorate the tree.

After the tree is once well into bearing, productivity can be gradually increased and then maintained more or less indefinitely at a high level by employing such cultural measures as tend to promote a fairly vigorous growth, shoot growth averaging four to eight inches in length. This can best be done through proper cultivation, cover cropping, and the use of suitable nitrogenous fertilizers, coupled always with spraying to protect the trees from the leaf spot disease. The importance of disease control cannot be over-emphasized in this connection because the evidence plainly indicates that the best of cultural treatments are inadequate to secure good growth and thus maintain productivity in blackhearted trees that result from premature defoliation. This, of course, assumes that the orchard is so located as to be reasonably free from injuries from frost and extreme winter cold and that suitable provision for pollination is made at the blossoming season.

SUMMARY

As the growth of vigorously growing young sour cherry trees slows down, fruit spurs and fruit buds are formed freely and the tree comes into bearing, mainly through fruit buds formed on spurs in some varieties and mainly through lateral fruit buds on shoots in others.

In the Montmorency cherry, spurs are formed freely only on shoots that are eight to 10 inches long or longer. These more vigorous shoots give rise to branch shoots almost as freely as they do to spurs. Both short and medium length shoots form lateral fruit buds freely.

The Montmorency variety normally bears fruit freely on both shoots and spurs. It can be made to bear on spurs only, or principally, by means of pruning treatment that results in reduced yield. There is no occasion for employing such treatment under Michigan conditions.

In short, Michigan growers need give no attention to the question of attempting to control the method of bearing, but should maintain the formation of a few leaf buds on each year's shoot growth.

In general, yields of trees well into bearing can be increased by forcing them to produce shoots averaging seven, eight, or more inches in length. They can be maintained by forcing them to produce shoots averaging five to seven inches in length.

Sod culture is not recommended for the sour cherry as it tends to slow down growth and therefore reduce yields.

The effect of nitrogenous fertilizers on healthy trees is to promote shoot grown, to enlarge bearing area, and to increase yields. They do not have such an effect on trees seriously affected with blackheart.

The general effect of pruning is to reduce bearing area and yields, in spite of increasing the vigor of shoots and branches that are left. Its effect on the fruit spurs is just the opposite. That is, it tends to weaken them. Very little pruning is to be recommended for sour cherry trees.

Premature defoliation, caused by leaf spot or other agencies, results in shorter and weaker shoots and greatly reduces the efficiency of individual fruit spurs and shortens their life.

The two most important things from the standpoint of increasing and maintaining the productivity of sour cherry trees are:

1. To employ such soil management methods as will promote a reasonably vigorous shoot growth, and
2. To control the leaf spot disease by proper spraying.

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