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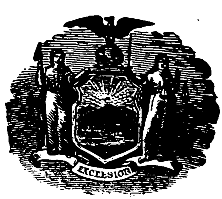
RESPONSES OF THE SOUR CHERRY TO FERTILIZERS AND TO PRUNING IN THE HUDSON RIVER VALLEY

H. B. TUKEY



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BULLETIN NO. 541

RESPONSES OF THE SOUR CHERRY TO FERTILIZERS AND TO PRUNING IN THE HUDSON RIVER VALLEY

H. B. TUKEY

ABSTRACT

This report treats of growth studies and of fertilizer and pruning tests with bearing Early Richmond, Montmorency, and English Morello sour cherry trees. Each variety shows a characteristic relation between length of terminal shoot and spur formation, lateral shoot formation, and production.

The average moderately vigorous sour cherry orchard in the Hudson River Valley may be expected to respond to applications of nitrogenous fertilizers even when kept clean cultivated and sown to a cover crop. No evidence has yet appeared showing any benefit from either phosphorus or potassium, alone or in combination. Because of the growing habit of the cherry, little or no increase in fruit yield may be expected the first year fertilizers are applied. The second season should see some gain and the third season a still larger one. Increases in terminal growth, trunk diameter, and leaf area and delayed maturity of fruit are accompanying responses.

Severe pruning to outside lateral branches in order to reduce the height of tall trees, as well as thinning out of unproductive wood and cutting back to outside lateral growths in order to restore vigor, has resulted in renewed growth when nitrogen applications have been made in combination with pruning; otherwise not.

INTRODUCTION

There are three major varieties of sour cherry produced in the Hudson River Valley, *viz.*, Early Richmond, Montmorency, and English Morello. They are extensively grown, especially Montmorency and English Morello, and in recent years have been among the outstandingly profitable orchard fruits. Experimental evidence regarding cultural practices that may be helpful to cherry growers is therefore especially desirable at this time.

The work reported upon in this publication treats of growth studies and of fertilizer and pruning tests with the three varieties named above, emphasis having been placed upon the varieties in the order of their economic importance, namely, Montmorency, English Morello, and Early Richmond. Altho the fertilizer and pruning tests have been in progress only three years, the evidence is so plain that it seems unnecessary to wait for additional data.[1]

THE PROBLEM

Each variety presents a problem in itself. In the case of Early Richmond the trees are tall growing and are picked with difficulty by the boys and girls usually employed for this work. Montmorency trees are not so erect, but they, too, grow out of hand, especially under the crowded conditions found in the majority of Hudson River Valley orchards. The trees of English Morello are small growing and seldom present this difficulty.

On the other hand, English Morello trees are frequently low producers, tho under optimum conditions they are very productive. Early Richmond trees are seldom highly productive, tho they, too, yield heavily upon occasions. Montmorency is characteristically a heavy producer, yet often not as productive as experience shows it might be.

Still another factor, time of fruit maturity, is becoming of increasing importance in the Hudson River Valley, the market paying a premium for Early Richmond early in the season and for Montmorency and English Morello late in the season. Blossom-bud hardiness is not of great concern in the major producing regions, altho in the Upper Hudson River Valley and the Lake Champlain sections it becomes so.

From this brief introduction the principal problems presenting themselves are seen to be:

1. The growing and fruiting habits of the sour cherry.

2. The response of the sour cherry to various cultural treatments directed at increased production.

3. The response of the sour cherry to pruning directed at lowering the height of the tree and also at increasing production.

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[1]The progress of the work has been materially assisted by the helpfulness of Wessel Ten Broeck, Wessel Ten Broeck, Jr., and R. L. Meyer, all of Hudson.

PREVIOUS RESULTS

Until quite recently, very little information was available on the growth and culture of the sour cherry. In 1910, Blake and Farley (1),[2] reporting upon a limited fertilizer test in New Jersey, observed a definite response in both yield and tree growth in trees growing on a heavy moist loam fairly rich in nitrogen which received nitrate of soda at the rate of 150 pounds per acre in addition to 500 pounds per acre of equal parts of ground bone, acid phosphate, and potash. Trees with which they were compared were also supplied with 500 pounds per acre of equal amounts each of ground bone, potassium chloride, and acid phosphate, the only difference between treatments lying in the nitrate of soda application.

Collison (5), in 1920, reported what seemed to be an increase in yield on a stony sandy loam in western New York due to nitrogen applications and to a lesser extent to potassium and phosphate. Growth responses measured by trunk diameter were considered problematical, while the cost of fertilizers was found to be more than the value of any increase in yield. Reporting upon the same experiment in 1923, Collison and Harlan (6) concluded that tree growth, as measured by trunk diameter, showed a definite response to nitrogen, altho yield records indicated no clear gain.

The work of Roberts (7, 8, 9, 10, 11) and of Roberts and Potter (12) in Wisconsin has added materially to information concerning the growing habits of the cherry and its response to fertilizers and pruning. In 1917, Roberts (7) showed that with the Montmorency and Early Richmond cherries yields might be affected by killing of fruit buds, more killing being associated with small tree growth and less injury with greater tree growth, the explanation lying in the retarded maturity of fruit buds where greater growth occurs. In 1919, Roberts (8) offered the explanation that generally on short growths, less than 6 inches in length, no spurs are formed and winter injury occurs to the blossom buds, while on growths over 12 inches in length most buds develop into spurs whose fruit buds are also less easily injured by cold. In 1922, he (10) carried the explanation still further and reported that Richmond trees receiving no fertilizer had 64 per cent of the blossom buds killed by winter cold in contrast to pruned and

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[2]Refers to Literature Cited, page 26.

nitrated trees where 19.5 per cent of the blossom buds were killed and to young trees where 10.0 per cent were killed.

Previous to this Roberts and Potter (12), in 1919, reported a definite response in yield of Early Richmond trees receiving nitrogenous fertilizer either alone or in combination with phosphoric acid and potash, but no gain for the last two by themselves. In addition, it was observed that trees receiving nitrogen carried a large proportion of their crop on two- and three-year-old spurs, while trees receiving no nitrogen produced their fruit largely from lateral buds on one-year-old wood precluding the possibility of spur formation.

In the same year Roberts (9) reported for both Early Richmond and Montmorency cherries an increase in the percentage of leaf buds on terminal growths coincident with an increase in their length. In the case of Montmorency, the increase ranged from 4.3 per cent with 4 inches of growth to 93.7 per cent with 18 inches, and in the case of Early Richmond from 2.3 per cent to 75.8 per cent for similiar lengths. It was also stated that pruning which reduced the number of terminals helped to keep up the length of the terminal growth and therefore to induce spur formation. Trees kept open and low responded in a similar way.

In the light of these findings the report of work by Roberts (11) in 1922 showed a decided gain from vigorous-growing trees, whether induced by pruning, nitrogen fertilizers, or a combination of both, and indicated that in Wisconsin cherry trees should be kept in a vigorous growing condition by means of cultivation, fertilizer application, and pruning in order to secure maximum yields.

Chandler (3), in 1925, tells of Montmorency cherry trees under a system of clean cultivation on a heavy clay soil in New York responding markedly in tree growth to nitrogen applications, altho apple trees under similar conditions failed to respond. On a light sandy soil at the Cornell Experiment Station cherry trees made striking increases in growth due to nitrogen applications when adjacent apple trees did not. He (4) has also indicated the higher proportion of long shoots on severely pruned young Early Richmond trees in contrast with the greater number of spurs and short growths on unpruned trees.

Bradbury (2) has suggested the importance of unfavorable nutritional conditions in bringing about arrested development and dropping of the immature sour cherry fruits. She has shown that 42 per cent of the blossom buds on spurs of two-year-old wood set fruit when they were thinned as early as practicable to one blossom to a bud, while only 24 per cent set fruit on unthinned branches.

GROWING AND FRUITING HABITS OF THE SOUR CHERRY

There are two kinds of buds on the cherry, namely, leaf buds, which carry no flower parts and which develop into wood growth, and blossom buds, which carry principally the flowers or fruit-producing parts, together with a few enclosing leaves (Plate I). Obviously the leaf buds are concerned with shoot and tree growth, while the function of the blossom buds is to produce fruit. Both kinds of buds may occur in any position on the treetop, side, inside, outside, and so on. They may also appear on any season's growth—such as one-year wood, two-year wood, three-year wood, and so on.

There are, moreover, two kinds of wood growth which develop from the leaf buds (Plate I). The one is characterized by a long vigorous growth, such as that of a sucker or a strong terminal shoot. The other is a short side growth, usually growing less than an inch in any one season and which is found on wood which is two years old or older. The vigorous-growing wood is commonly called a "shoot" in contrast to the slow-growing wood which is commonly called a "spur." Either type may or may not bear fruit.

Normally, the spur is a cluster of blossom buds which develop into flowers and fruit. On the other hand, the vigorous-growing shoot normally develops only leaf buds. Under certain conditions, however, the shoot growth of a tree may develop blossom buds instead of leaf buds, that is it may form blossom buds as side buds or lateral buds during the same season that it is making its growth. The next season these blossom buds may blossom and fruit, and when the fruit has been picked the growth is bare of both fruit and foliage. In fact the terminal or wood growth of a cherry tree may be so short that it approaches a spur in its general fruiting habits, but for the purpose of this discussion only the short growths occurring on wood two years old or older will be considered as spurs. The conditions that determine position of blossom bud formation are very important in cherry production. They will be discussed in detail with each of the varieties in turn.

MONTMORENCY

In the case of the Montmorency cherry observations show that the high-producing trees bear their fruit largely on spurs instead of on terminal one-year wood. Counts made in a productive orchard of 24-year-old Montmorency trees which have averaged 190 to 200 pounds of fruit per tree for several years show 80.8 per cent of the fruit borne on spurs and only 19.2 per cent on one-year-old terminal wood. This may be accounted for in two ways, namely, spur formation is a noticeable characteristic of the growth of these trees, resulting in a large number of fruiting spurs, and blossom bud formation on one-year-old terminal growth is low, resulting in a small amount of fruit being borne on such wood (Plate II).

That there is a distinct difference in the type of growth on trees in very productive and moderately productive orchards is shown by a glance at Table 1 where measurements of the 1921, 1922, and 1923 terminal growth on 20 trees in two orchards are classified in arbitrary groups of 0 to 5 inches in length inclusive, 6 to 10 inches inclusive, 11 to 15 inches inclusive, and 16 to 20 inches inclusive. It will be

TABLE 1.—RELATION OF LENGTH OF TERMINAL SHOOT TO FRUIT PRODUCTION IN MONTMORENCY CHERRY.

ORCHARD	PERCENTAGE OF SHOOTS IN CLASS			
	0–5 inches	6–10 inches	11–15 inches	16–20 inches
Moderately productive orchard	79.0	17.7	2.9	0.2
High-producing orchard	18.1	32.4	37.6	11.7

TABLE 2.—RELATION OF LENGTH OF SHOOT TO TYPE OF GROWTH IN MONTMORENCY CHERRY.

TYPE OF GROWTH	YEAR	LENGTH OF SHOOTS IN INCHES			
		0–5	6–10	11–15	16–20
Percentage forming spurs	1921	4.8	64.0	100.0	——
	1922	10.4	82.6	100.0	100.0
Average number of spurs on spurred shoots	1921	1.6	3.6	7.2	——
	1922	2.0	6.7	7.7	12.0
Percentage forming laterals	1921	3.6	68.0	87.5	——
	1922	0.0	10.8	74.8	100.0
Average number of laterals on shoots forming laterals	1921	2.1	3.0	4.0	——
	1922	0.0	1.5	2.3	3.0

noticed that in the case of the high-producing trees approximately one-third of the growths are between 6 and 10 inches in length, while approximately one-third more are between 11 and 15 inches. On the other hand, approximately three-fourths of the shoots from the moderately productive trees are 5 inches or less in length.

The importance of these facts will be apparent from a study of Table 2 in which it is shown that shoots making short growth, classified as 5 inches and less, seldom either form spurs or make strong lateral shoots. On the other hand, shoots making strong growth, classified as 6 inches and more, usually form either spurs or strong laterals. As the growth increases the number of spurs increases until with very strong growths laterals are formed at the expense of spurs, and these also increase in number as the growth increases in length. Measurements are for growths made in 1921 and 1922, the number of spurs and shoots being recorded separately for each year.

Obviously, shoots forming spurs are more productive than those which do not, for in the former case spurs may bear repeatedly, while in the latter case nothing but bare wood remains after the terminal growth has fruited (Plate II). A succession of terminal fruiting shoots over a period of years appear to be long, unproductive branches. They *are* unproductive, but for the reason that in previous years they have formed blossom buds instead of leaf buds so that no spurs or lateral shoots have been formed. Once the fruit is picked from them they do not bear again.

Altho good growth and high production are closely associated and altho the reasons given above are chiefly responsible for high yields, there are other reasons. To begin with, even tho trees are fruiting on terminal shoots, the possibility of increasing production by increasing shoot length is shown by counts made on 20 trees during the 1923 season. It was found that growths averaging 0.9 inch in length carried from three to five blossom buds. Those averaging 2.1 inches in length had six to eight blossom buds, while shoots averaging 5.4 inches in length carried nine or more blossom buds. The more blossom buds that a shoot carries, the more cherries it is able to produce, so that even tho spurs may not be formed, increasing the growth increases the possibilities of a larger crop.

Still another factor enters in, namely, winter injury. It has been shown by other workers that blossom buds on spurs are hardier against winter cold than are blossom buds on one-year-old terminal wood. No counts have been made to determine how important this factor is in the Hudson River Valley, but during the seasons of 1923, 1924, 1925, and 1926 it was not of sufficient importance to attract attention. That it may be of importance in colder sections or in years more favorable to winter injury is indicated by Plate III, where spur blossom buds are seen to have lived thru the winter whereas lateral blossom buds on one-year wood have perished.

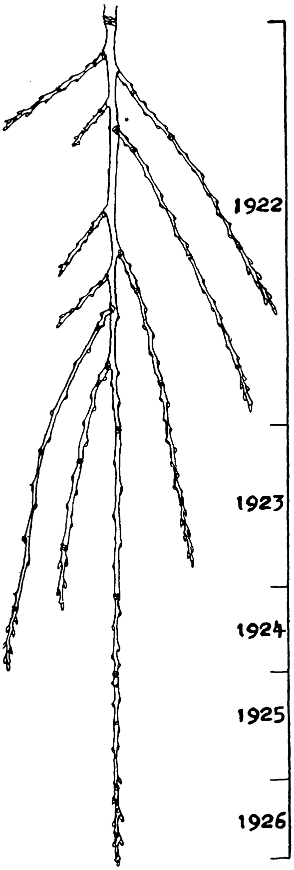

FIG. 1.—TYPICAL GROWTH OF ENGLISH MORELLO.

Productive because of the lateral shoots formed in 1923 on 1922 wood which have fruited annually on terminal growths since then.

To sum up briefly the growing habit of the Montmorency cherry, shoots over 6 inches in length tend to form leaf buds in contrast with blossom buds which are formed largely by shoots less than 6 inches in length. The leaf buds develop into spurs or strong lateral shoots—mostly spurs in the case of shoots between 6 and 15 inches in length which bear repeatedly in subsequent years. The blossom buds on one-year-old wood, however, fruit and leave barren wood behind. Trees in high-producing orchards have a high proportion of terminal shoots over 6 inches in length, while low-producing orchards have a high proportion of terminal shoots less than 6 inches in length. A possible contributing factor in yield is winter injury, in which blossom buds on spurs are found to be hardier than blossom buds on one-year wood.

ENGLISH MORELLO

English Morello trees behave quite differently from either Montmorency or Early Richmond. The chief characteristic of English Morello growth is the tendency to produce strong lateral growths instead of spurs. The lateral shoots in turn tend to fruit terminally as in the case of short-growing Montmorency shoots, which means that the most of the fruit is borne on one-year-old wood rather than on spurs on older wood (Fig. 1). When the fruit is gathered bare wood remains, and this occurring year after year gives rise to the characteristic long, bare, terminal fruiting English Morello shoots. A branch of this variety may be likened in appearance to a cat-o'-nine-tails, and old trees are thick with this type of wood (Plate V, A).

That old weak trees bear almost entirely in this manner is shown by a study of an 18-year-old English Morello orchard in which during the seasons from 1921 to 1925, inclusive, it was impossible to find any growths over 5 inches in length, the majority being between 1.1 and 2 inches. Furthermore, an examination to ascertain where the fruit was borne showed that 98.3 per cent was borne terminally and only 1.7 per cent on spurs. The cherries occurred singly or in twos, never in threes.

At the same time young vigorous trees present quite a different picture. A study of vigorous 6-year-old trees showed no terminal growths 5 inches or less in length during the seasons of 1922, 1923, 1924, 1925, and 1926. The older growths were grouped as follows: 6.2 per cent between 6 and 10 inches in length; 62.6 per cent between 11 and 15 inches; 25.0 per cent between 16 and 20 inches; and 6.1 per cent between 21 and 25 inches in length. Furthermore, there was no exception to the rule that growths over 9 inches in length formed both spurs and laterals. Arranging the lengths into the arbitrary groups adopted for this discussion, all of the growths between 6 and 10 inches in length developed both spurs and laterals, the average number of spurs being seven to the shoot and the average number of laterals being three. Those between 11 and 15 inches averaged 7.2 spurs and 5.1 laterals; those between 16 and 20 inches, 12 spurs and 7 laterals; and those between 21 and 25 inches, 12 spurs and 9 laterals. The interesting point brought out is the high proportion of strong lateral growths produced on vigorous English Morello wood as contrasted with the spur formation of the Montmorency variety.

The average growth by years on five normal English Morello trees six years of age further illustrates this fact. In 1926, the current season, the growth averaged 13.1 inches, and of course no spurs or laterals were found. In 1925, the growth was 15.5 inches, averaging nine spurs and six laterals; in 1924, 17.0 inches, averaging seven spurs and seven laterals; in 1923, 15.0 inches, averaging eight spurs and four laterals; and in 1922, 13.0 inches, averaging two spurs and five laterals. There is variation in the different seasons, but the characteristic high proportion of lateral growths predominates thruout.

How these laterals behave in subsequent years when the trees are older has been suggested by reference to the 18-year-old English Morello orchard in which most of the terminal growths were between 1.1 and 2 inches. A detailed study of the behavior of five laterals which were thrown out in 1920 by a 15-year-old tree on wood of the preceding season are given in Table 3 as typical of the English Morello variety.

TABLE 3.—GROWTH IN INCHES OF FIVE LATERALS ON AN ENGLISH MORELLO TREE.

SEASON	LATERAL No. 1	LATERAL No. 2	LATERAL No. 3	LATERAL No. 4	LATERAL No. 5
1926	0.5	3.2	1.0	1.5	4.0
1925	2.5	4.0	4.0	5.0	3.7
1924	0.7	4.0	2.0	5.0	1.5
1923	0.3	1.0	0.5	1.0	0.2
1922	0.2	5.0	0.5	0.5	0.2
1921	2.8	1.0	0.5	1.5	1.2
1920	5.2	4.5	5.0	4.5	5.3

No spurs or laterals appeared on any of the growths, each one fruiting on terminal wood in previous years and making a short terminal growth corresponding in a general way to the growth of spurs in the Montmorency variety. It must not be thought, however, that English Morello trees may not produce spurs, for in the following experiments it will be shown how spur formation has been induced.

Finally, annual shoot measurements (Table 4), together with counts of spur and lateral shoot formation for the years 1916 to 1925, inclusive, in a large high-producing commercial orchard 16 to 18 years of age, give an approximation of the general habit of the English Morello in orchards of this type. When classified as to length, it is seen from the first part of Table 4 that the percentage of shoots forming spurs and those forming laterals are similar for lengths of 20 inches or less, few growths less than 11 inches forming either spurs or laterals whereas most growths between 11 and 20 inches form both spurs and laterals. Beyond this length spur formation decreases at the expense of increase in lateral shoot formation.

In another commercial orchard a few years younger the measurements for 1921 to 1925, inclusive, show the same general trend as noted in the second part of Table 4. It will be observed that on the younger trees the tendency is to form spurs and lateral shoots on shorter season's growths than is the case with older trees. That diameter of shoot is related to this condition is suspected from general

Table 4.—Relation of Length of Growth to Spur and Lateral Shoot Formation in English Morello Cherry as Determined by Annual Measurements of Trees of Different Ages from 1921 to 1925.

Type of growth	Length of growth in inches				
	0–5	6–10	11–15	16–20	21–25
Trees 16 to 18 years of age					
Percentage forming spurs	5.9	5.1	87.8	87.5	50.3
Average number spurs on shoots forming spurs	0.5	2.4	4.7	6.8	4.5
Percentage forming laterals	2.5	4.2	96.9	100.0	100.0
Average number laterals on shoots forming laterals	1.0	1.3	4.9	6.3	8.3
Trees 15 years of age					
Percentage forming spurs	0	32.9	64.6	100.0	——
Average number spurs on shoots forming spurs	0	1.8	3.0	3.3	——
Percentage forming laterals	0	17.0	100.0	100.0	——
Average number laterals on shoots forming laterals	0	0.3	7.6	12.0	——

observation, but no studies have been made to determine this point definitely.

To sum up, then, young vigorous English Morello trees tend to produce numbers of both spurs and lateral shoots on the preceding season's growth, the number of spurs and laterals from each growth increasing as the length of growth increases. The lateral shoots so formed tend to fruit at the tips in following years and to make relatively short growths. The fruit having been gathered from the preceding season's terminal growth and no spurs and laterals having been formed on them, long barren growths fruiting at the tips are the result, characterizing the general appearance of the English Morello tree. It is plain that with this type of growth the trees must contain an increasingly greater proportion of unproductive wood as they grow older.

EARLY RICHMOND

The Early Richmond cherry behaves very much like its near relative, Montmorency, so that it will be but briefly discussed. Table 5 shows the tendency for shoots to form both spurs and lateral shoots as growth increases. The main differences between the Early Richmond and Montmorency tree are in the lower vigor of Early Richmond and its tall, upright habit of growth. Other workers have reported the failure of fruit spurs of Early Richmond to fruit in successive years.

Table 5.—Relation of Shoot Growth to Spur and Lateral Shoot Formation in Early Richmond Cherry.
(1918 to 1925. Trees 24 years of age.)

Type of growth	Length of growth in inches		
	0–5	6–10	11–15
Percentage forming spurs	5.8	55.5	100.0
Average number spurs on shoots forming spurs	1.0	5.0	7.5
Percentage forming laterals	0.0	0.0	100.0
Average number laterals on shoots forming laterals	0.0	0.0	2.0

SUMMARY ON GROWING AND FRUITING HABITS OF THE SOUR CHERRY

Trees of the Early Richmond and Montmorency are similar in their growing and fruiting habits, tho those of the former are less vigorous and are more upright in habit. Montmorency shoots over 6 inches in length tend to form leaf buds in contrast with blossom buds which are formed largely by shoots less than 6 inches in length. The leaf buds develop into either spurs or strong lateral shoots, but mostly spurs in the case of shoots between 6 and 15 inches in length which bear repeatedly in subsequent years. The blossom buds on one-year-old wood, however, fruit and leave barren wood behind.

Trees of English Morello differ chiefly in growing and fruiting habit from those of Early Richmond and Montmorency in that they tend to produce a high proportion of lateral growths instead of spurs. Young vigorous English Morello trees produce numbers of both spurs and lateral growths on the preceding season's growth, the number of spurs and laterals from each growth increasing as the length of growth increases. The lateral shoots so formed tend to fruit at the tips in following years and to make relatively short growth. Fruiting this way in successive years without spur or lateral shoot formation produces the long baren growths so characteristic of the variety.

The length of terminal growth associated with spur and lateral shoot formation differs with the season and the age of the tree, younger trees tending to spur formation on shorter lengths. Nevertheless the general relation of terminal growth to spur and lateral shoot formation holds in all cases studied. It would seem that any optimum growth conditions that might be formulated would be of

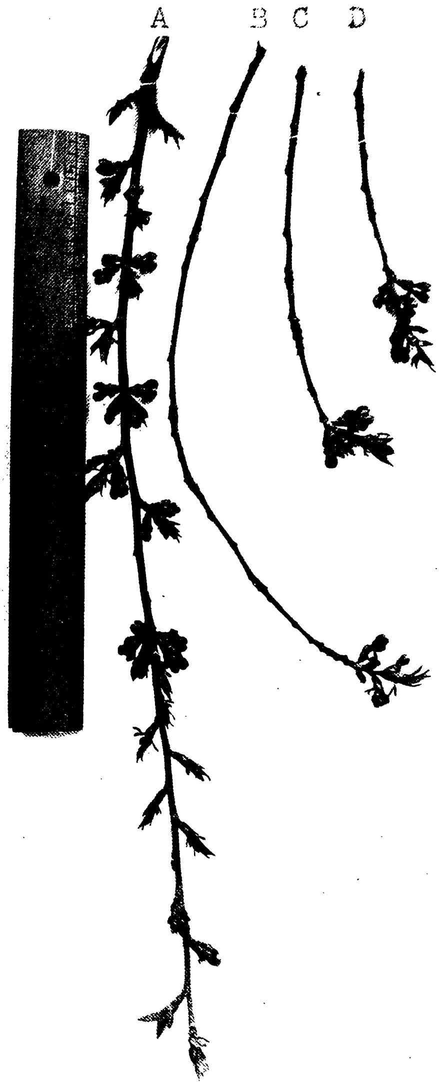

PLATE I.—TWO TYPES OF BUDS AND TWO TYPES OF WOOD IN THE MONTMORENCY CHERRY.

(A) Productive wood, two years' growth, with fruiting spurs on vigorous two-year-old wood, and mostly leaf buds on one-year-old wood. (B, C, D) Unproductive wood, four to six years' growth, fruiting only from blossom buds formed on one-year-old wood.

PLATE II.—A COMPARISON BETWEEN HIGH PRODUCTNIO AND LOW PRODUCTION.
The shoot on the left represents three years' growth with fruiting spurs. The shoot on the right represents seven years' growth with no fruiting spurs.

PLATE III.—RELATIVE HARDINESS OF FRUIT BUDS FORMED ON SPURS AND THOSE FORMED ON TERMINAL SHOOTS.

(A) The blossom buds on one-year wood have not survived the winter, while the blossom buds on spurs are in bloom. (B) Vigorous growths form leaf buds on one-year wood which develop into spurs the following year and bear fruit the third season. (C) Weak growths form blossom buds on one-year wood and after they have fruited bare wood remains which after a succession of years gives long unproductive branches.

questionable value, yet the understanding of the principles involved is an unmistakable asset in interpreting the behavior of trees under various sets of conditions.

RESPONSE OF THE SOUR CHERRY TO FERTILIZERS

Altho the orchard in which the following fertilizer test was conducted is of the Montmorency variety, observations and studies in nearby English Morello and Early Richmond orchards indicate that the same responses may be expected from these two varieties. Therefore, they will not be discussed further in this section.

In the Spring of 1924 fertilizer applications were made to a Montmorency orchard the property of Wessel Ten Broeck and Wessel Ten Broeck, Jr., adjoining the City of Hudson to the south. The elevation is 200 feet. The soil grades from a gravelly silt loam to a silt loam. It is a level tract sloping gently towards the Hudson River to the west in the lengthwise direction of the plats into which the orchard is divided for the tests. At the lower or west end the soil is heavier than at the upper or east end, but being uniform in its distribution across the lower ends of the plats it has not interfered with the results.

The upper or east end of the orchard has no adjacent plantings. At the lower or west end a Kieffer pear orchard is continuous with the cherry rows. The trees in the cherry orchard are 10 in a row, planted 18 feet by 18 feet, and are alternately solid rows of Montmorency trees and rows of alternate cherry and apple trees, thus providing a natural "division" row or "buffer" row between the solid rows of Montmorency trees used

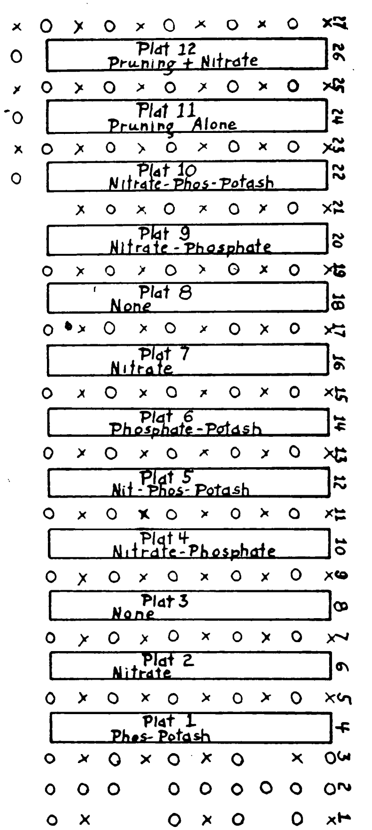

FIG. 2.—PLAN OF FERTILIZER AND PRUNING TEST WITH MONTMORENCY CHERRIES.

in the tests. It will be seen at once that the orchard is ideally adapted to a fertilizer test of this kind (Fig. 2).

Fertilizer applications were made in duplicate with 10 trees to a plat as indicated below, thus giving 20 trees to a treatment.

Plat 1 and 6—Acid phosphate and muriate of potash.
" 2 and 7—Nitrate of soda.
" 3 and 8—Nothing.
" 4 and 9—Nitrate of soda and acid phosphate.
" 5 and 10—Nitrate of soda, acid phosphate, and muriate of potash.

The amounts applied were as follows:

Nitrate of soda, 2¼ pounds per tree, equivalent to 50 pounds of nitrogen per acre.
Acid phosphate, 2 pounds per tree, equivalent to 50 pounds of phosphoric acid per acre
Muriate of potash, 1 pound per tree, equivalent to 100 pounds of K_2O per acre.

Each fertilizer was applied separately in a circle about each tree, which in this case is the same as being spread broadcast because the trees are close together. The nitrate of soda was applied in the spring just as the buds were breaking. The acid phosphate and muriate of potash were applied the first week in May the first two seasons and the fall of the preceding season the next year. That is to say the first application was made in May 1924, the second in May 1925, and the third in October 1925.

The orchard is kept clean cultivated and has had a late non-leguminous cover crop growing. The orchard management would be considered exceptionally good. Spraying and dusting procedure is such as to give complete control of insect pests and fungous diseases. The trees were planted in 1908.

EFFECT UPON SHOOT GROWTH

From the discussion of the fruiting habit of the sour cherry it is to be expected that the first response to fertilizer applications would be in growth rather than in yield. Such was the case. In the fall of 1924 counts were made of the number of 1924 shoots in each plat which were 6 inches or more in length. Table 6 shows clearly the response due to nitrogen applications. Altho there are differences between plats receiving other materials than nitrogen alone, they are not significant. The table shows an increase in shoot growth wherever nitrogen has been applied. Nothing else can be inferred. Viewed in the light of the studies of shoot growth and fruiting habit these figures point to increases in yield of fruit in future years.

TABLE 6.—EFFECT OF FERTILIZER APPLICATIONS UPON SHOOT GROWTH OF MONTMORENCY CHERRY.

Treatment	Plat No.	Number of trees	Number of new shoots 6 inches or more in length	
			Per plat	Total
Acid phosphate and muriate of potash	1 6	10 10	576 226	802
Nitrate of soda	2 7	10 10	1,117 870	1,987
Nothing	3 8	10 10	270 318	588
Nitrate of soda and acid phosphate	4 9	10 10	991 918	1,909
Nitrate of soda, acid phosphate, and muriate of potash	5 10	10 10	961 690	1,651

EFFECT UPON YIELD

The fruit has been gathered in 4-quart baskets, averaging 7½ pounds of fruit each. The crop in 1924, the first year of fertilizer application, showed no differences due to treatments. The only correlation was between yield and size of tree, accounting for most of the differences between rows. The second season, however, those trees receiving nitrogen were noticeably higher in yield than those that did not receive nitrogen. The third season's crop continued in the same direction with even greater proportionate gain where nitrogen had been applied. Table 7 shows these points very clearly, the two-year gain in favor of nitrogen ranging from 82.5 4-quart baskets to 118.6 based on 20 trees.

Curiously enough nitrogen by itself has given the greatest yield among the treatments receiving nitrogen, while nitrogen in combination with phosphorous is next and complete fertilizer last. Yet the differences are not large and indicate the uniform benefit from nitrogen in contrast to no apparent gain from the other fertilizers in combination with nitrogen. Further substantiating this view is the record of the trees receiving phosphorous and potassium which, altho they show a gain over the check, are close enough in yield to indicate that the gain is without significance.

TABLE 7.—EFFECT OF FERTILIZER APPLICATIONS UPON YIELD OF FRUIT IN MONTMORENCY CHERRY.

TREATMENT	PLAT No.	NUMBER OF TREES	YIELD IN 4-QUART BASKETS COMPUTED AS FOR 10 TREES				
			1924	1925	1926	Total, 1925 and 1926	Grand total, 1925 and 1926
Acid phosphate and muriate of potash	1 6	8 8	46 38	90.0 78.7	45.8 41.2	135.8 119.9	255.7
Nitrate of soda	2 7	10 10	48 40	101.0 112.5	77.9 55.9	178.9 168.4	347.3
Nothing	3 8	8 9	42 39	82.0 65.3	44.3 37.1	126.3 102.4	228.7
Nitrate of soda and acid phosphate	4 9	9 10	33 43	110.2 97.7	74.2 62.6	184.4 160.3	344.7
Nitrate of soda, acid phosphate, and muriate of potash	5 10	9 6	41 37	90.0 87.0	71.2 63.0	161.2 150.0	311.2

The increases in yields agree also with the findings from studies of the growing and fruiting habits of the Montmorency cherry. The first year's response to nitrogen applications is an increase in shoot growth. The second season some of these longer shoots bear fruit and some form spurs. The third season the spurs fruit. That this

TABLE 8.—EFFECT OF FERTILIZER APPLICATIONS UPON TRUNK GROWTH IN MONTMORENCY CHERRY.

TREATMENT	PLAT No.	NUMBER OF TREES	GAIN IN TRUNK DIAMETER IN INCHES COMPUTED AS FOR 10 TREES, 1923 TO 1926	
			Per plat	Total
Acid phosphate and muriate of potash	1 6	8 8	6.8 6.8	13.6
Nitrate of soda	2 7	10 10	9.3 9.2	18.5
Nothing	3 8	8 9	6.8 7.2	14.0
Nitrate of soda and acid phosphate	4 9	9 10	8.9 9.0	17.9
Nitrate of soda, acid phosphate, and muriate of potash	5 10	9 6	9.3 8.4	17.7

has been the procedure in this orchard is evident from the figures recorded here.

EFFECT UPON TREE GROWTH

Trunk diameter is a good index of tree performance, for in the annual rings of wood which a tree makes it records its own history. Trunk diameter measurements were made at the beginning of the test and again in the fall of 1926, after three seasons of fertilizer applications. Measurements were made with calipers at a point 12 inches above the ground line. The evidence given in Table 8 is very plain in showing the increase in growth wherever nitrogen was applied, and no apparent increase from any of the other fertilizers used.

EFFECT UPON SIZE OF LEAF

The leaves are the laboratories for the conversion of food materials into food available to the plant for growth and fruiting. Both the number of leaves and size of leaf are therefore important indications of what a tree is doing. In the orchard under consideration there has been definite increase in leaf area wherever nitrogen has been used and no significant gain from any of the other fertilizers. Measurements were made by counting the squares covered on cross-ruled paper, five lines to the inch. The fourth and fifth leaves from terminal shoots were selected as being the most uniform. Table 9 brings out these facts very well.

TABLE 9.—EFFECT OF FERTILIZER APPLICATIONS UPON LEAF SIZE IN MONTMORENCY CHERRY.

Treatment	Plat No.	Number of trees	Average area in square inches	
			Per plat	Average
Acid phosphate and muriate of potash	1 6	8 8	6.27 6.20	6.23
Nitrate of soda	2 7	10 10	7.30 7.40	7.35
Nothing	3 8	8 9	6.38 5.92	6.15
Nitrate of soda and acid phosphate	4 9	9 10	7.36 7.24	7.30
Nitrate of soda, acid phosphate, and muriate of potash	5 10	9 6	7.28 7.16	7.22

EFFECT UPON MATURITY OF FRUIT

Nitrogen applications delayed the maturity of the fruit all three seasons, the difference between the plats receiving nitrogen and those not receiving nitrogen being about 10 days. Furthermore, the cherries were brighter and more attractive. Both of these factors have direct application in cherry marketing in the Hudson River Valley.

CONCLUSIONS ON FERTILIZER TESTS

To sum up, then, nitrogen applications made during 1924, 1925, and 1926 to a commercial Montmorency orchard, 10 trees to a treatment in duplicate, show plainly a response to nitrogen but as yet no gain from either acid phosphate and muriate of potash or any additional increase when in combination with nitrogen. Increased shoot growth, larger yields, greater leaf area, and gain in trunk diameter agree very closely in establishing these conclusions. Furthermore the yield and shoot growth records agree in general with the studies of fruiting and growing habits. Together they show why no increase in yield may be expected the first year, why some increase may appear the second year, and why a substantial gain may be expected the third year. The maturity of the fruit has been delayed about 10 days during each season that nitrogen has been applied.

RESPONSES TO PRUNING IN COMBINATION WITH FERTILIZERS

MONTMORENCY

As has already been stated, one of the problems with the Montmorency tree is its tendency as it grows older to become too tall for easy harvesting of its fruit which is then carried largely in the top of the tree. An illustration in point is that of the orchard in which pruning and fertilizing tests were carried on where counts revealed more than 90 per cent of the high-yielding wood to be in the tops (Table 10).

Two rows of 10 trees each were studied, and the shoots on each tree classified as to their location, anything up to 8 or 10 feet from the ground being considered as the side and anything above that being considered the top. It is evident that under these conditions lowering of the fruiting top would be a great advantage.

In the spring of 1924 an attempt was made to lower the top of the trees in two rows of 10 trees each adjacent to the rows employed in

TABLE 10.—THE POSITION OF VIGOROUS FRUITING WOOD ON MONTMORENCY TREES.

Type of growth	Row No.	Position on trees	
		Sides	Top
		Per cent	*Per cent*
Spurred shoots	1	9.1	90.9
	2	0.4	99.6
Shoots with lateral growth	1	3.2	96.8
	2	0.0	100.0
Fruiting buds	1	33.4	66.6
	2	32.8	67.2

the fertilizer test as shown in Fig. 2 and in the same Montmorency orchard. Pruning consisted in cutting back to outside lateral branches and resulted in heavy cutting. With some trees the tops were lowered 6 or 7 feet and branches 2 inches in diameter were removed, always cutting to an outside lateral growth so that the energy of the tree might expend itself in renewing some of the old wood rather than asserting itself in sucker growth as might otherwise be the case. In the two years thereafter pruning was very moderate, consisting in thinning out undesired shoots (Plate IV).

In addition to pruning, one row of trees received nitrate of soda, 2¼ pounds to the tree, as in the adjoining fertilizer test.

EFFECT UPON YIELD

The yield was materially reduced in both rows the first season after pruning as shown in Table 11, altho to a lesser degree where nitrogen was applied than where it was not. The second season the yield was still below that of the untreated trees, but it will be observed that the pruned trees receiving nitrogen had made a large increase over the pruned trees which received no nitrogen, and were not far behind the trees receiving no treatment at all. By the third season the pruned trees receiving nitrogen had passed the check trees in yield, while the pruned trees which received no nitrogen were still

TABLE 11.—EFFECT OF HEAVY PRUNING UPON YIELD OF MONTMORENCY CHERRY.

Treatment	Plat No.	Yield in 4-quart baskets			
		1924	1925	1926	Total
Pruning and nitrogen	12	26.0	52.0	67.0	145.0
Pruning alone	11	20.0	38.2	35.0	93.2
No treatment	3, 8	40.5	73.6	40.7	154.8

lagging behind. In fact the total yield for the three seasons is not widely different between the pruned trees receiving nitrogen and those receiving nitrogen with no pruning, while from the condition of their growth they should forge rapidly ahead. By turning back to Table 7 it will be seen that the trees receiving nitrogen and pruning have almost caught up to the trees receiving nitrogen without pruning.

EFFECT UPON GROWTH

Measurements of trunk growth, area of leaf, and shoot growth all agree with the figures of fruit yield. Pruning alone did not stimulate the formation of new shoots the first year as compared with trees not pruned, while pruning plus nitrogen gave a marked response.

The increase in trunk diameter from 1924 to 1926 was decidedly less where pruning alone was done, while even pruning plus nitrogen produced less gain than where no treatment was given. The explanation, of course, lies in the dwarfing effect from removing so much of the leaf area as this type of pruning involves. The pruned trees receiving nitrogen, however, recovered quickly. In fact the leaf area measurements made in 1926 indicate that these trees have not only recovered but are now surpassing the check trees in growth, tho the pruned trees not receiving nitrogen are no better than the check trees in this respect. Table 12 gives the figures upon which this discussion is based.

TABLE 12.—EFFECT OF HEAVY PRUNING UPON GROWTH OF MONTMORENCY CHERRY.

TREATMENT	PLAT No.	SHOOTS OVER 6 INCHES IN 1924	LEAF AREA IN 1926, SQUARE INCHES	INCREASE IN TRUNK DIAMETER 1924–26, INCHES
Pruning and nitrogen	12	1,116	7.10	6.2
Pruning alone.......	11	320	6.08	4.7
No treatment.......	3, 8	401	6.03	7.0

DISCUSSION AND SUMMARY OF PRUNING TESTS

Trees receiving severe thinning out by cutting back to outside lateral branches so as to lower their height yielded much less fruit the first year than those not cut back, the reduced yield being due to the removal of fruiting wood. Trees cut back which also received nitrogen applications had overtaken and passed the check trees in yield by the third season, while pruned trees which did not receive nitrogen were still behind.

Pruning checked the total tree growth the first season. Pruned trees which received nitrogen, however, produced many vigorous new shoots the same season, and by the end of the third season had recovered and appeared more vigorous than untreated trees. Pruned trees which did not receive nitrogen applications were dwarfed and failed to equal the untreated trees.

ENGLISH MORELLO

With the English Morello tree, which, as has already been shown, is a slower-growing, lower tree than either Montmorency or Early Richmond, the question of lowering the height is not important. The problem is rather one of renewing the fruiting wood so as to maintain yield. The previous discussion of the fruiting and growing habit of the English Morello variety has shown the importance of these factors.

Tests were conducted with the cooperation of R. L. Meyer, 2 miles south of the City of Hudson, in whose orchard are English Morello trees of different ages which have been receiving different treatments. The owner has practiced thinning the trees out and cutting back to outside lateral branches during the last four or five years, together with applications of nitrogenous fertilizers (3 pounds of ammonium sulfate to the tree).

It has been shown that old English Morello trees tend to fruit laterally on one-year-old wood making short annual growths, but that vigorous young trees form both spurs and strong lateral shoots and bear largely on spurs. Cutting back and fertilizing old trees as described has resulted in renewing the growth of old trees, inducing spur formation, and accordingly increasing yield. The accompanying photograph (Plate V,B) shows the vigorous new wood that these trees have produced and the system of spurs which have developed. A study of these trees shows a relatively high proportion of vigorous spurred shoots as contrasted with old trees previously discussed.

Table 13 gives the record of new growth induced by this treatment, measurements being made where cuts had been made in 1922. Spur and lateral shoot formation has plainly been induced, tho curiously the tendency is for new shoots of this kind to form spurs rather than lateral shoots. The new growth is also characterized by its erectness and good diameter, altho the importance of these facts has not been determined.

TABLE 13.—EFFECT OF PRUNING AND FERTILIZING ON THE GROWTH OF ENGLISH MORELLO TREES.
(A record of growth adjacent to pruning cuts made in 1922.)

Type of growth	Length of new growth in inches			
	1923	1924	1925	1926
Average growth	7.5	8.5	9.4	4.6
Average number of spurs formed	9.1	5.4	9.0	—
Average number of laterals formed	1.0	1.5	0.4	—

In another test trees were severely thinned out, that is many of the characteristically long bare shoots of English Morello were removed. Altho no response in the growth of the trees was observed from this treatment as compared with trees not so pruned, the size and quality of the fruit were noticeably improved and the total yield was not reduced. Thinning out was done during the winter of 1925 and 1926 and 3 pounds of ammonium sulfate were applied to each tree the same spring, some trees receiving heavy thinning and some only light thinning but both being cut back and fertilized.

The fruit from severely thinned trees averaged 29/32 of an inch in diameter, with many fruits reaching 30/32 and 1 inch. The trees lightly thinned out averaged fruit 25/32 of an inch in diameter. Counts of the number of cherries in a 4-quart basket showed 580 cherries to the basket from lightly thinned trees and 528 cherries to the basket from severely thinned trees.

The evidence is plain, therefore, that English Morello trees respond to cutting back and thinning out in conjunction with nitrogen application much as do Montmorency trees as shown in the preceding paragraphs.

EARLY RICHMOND

Early Richmond trees, because of their tall upright habit of growth, are particularly needful of a type of pruning that will bring their fruiting area closer to the ground. It is not unusual to find old trees of this variety 30 feet in height.

Trees between 25 and 30 feet in height receiving 3 pounds of ammonium sulfate per tree were severely pruned during the winter of 1924 to 1925 in an effort to lower their tops. Pruning consisted of cutting back to outside lateral growths as was done in the case of the Montmorency trees described in previous paragraphs, excepting that the cutting was more severe. Branches 6 to 8 feet long and 2 to 3 inches in diameter were frequently removed.

Unfortunately it was impossible to secure satisfactory data in regard to yield but measurements of growth, as given in Table 14, indicate that the response of Early Richmond has been similar to that of its close relative, Montmorency.

TABLE 14.—GROWTH RESPONSE OF EARLY RICHMOND TO PRUNING IN CONJUNCTION WITH FERTILIZER APPLICATION.

TYPE OF GROWTH	BEFORE TREATMENT, 1919–24	ADJACENT TO CUTS MADE IN PRUNING, 1924–25
Percentage forming spurs	0.0	86.4
Percentage forming laterals	0.0	73.2
Average number of spurs on shoots forming spurs	0.0	8.0
Average number of lateral shoots on shoots forming laterals	0.0	2.5
Average growth, inches	1.9	9.3

DISCUSSION AND CONCLUSION

The average moderately vigorous sour cherry orchard in the Hudson River Valley may be expected to respond to applications of nitrogenous fertilizers even when kept clean cultivated and sown to a cover crop. No evidence has yet appeared showing that any benefit may be expected from either phosphorous or potassium when used alone or in combination with nitrogen or with each other.

Because of the growing habit of the cherry, little or no increase in fruit yield may be expected the first year fertilizers are applied. Where nitrogen is a limiting factor the second season should see some gain and the third season a still larger one. Increased shoot growth, greater growth of the trees, larger leaf size, and delayed maturity of fruit are accompanying responses.

Early Richmond and Montmorency trees are similar in their growth and fruiting habits, tho the former is more erect and grows taller. Trees which have reached too great a height for economical harvesting may be lowered by severe pruning consisting in cutting to outside lateral branches. Pruning alone, however, is not in itself sufficient. Nitrogen applications have been necessary in order to restore severely pruned trees to improved vigor. The first season a decrease in yield may be expected, the second season the yield may be expected to have recovered largely, and the third year it may be expected to surpass that of the untreated trees.

English Morello trees behave in much the same way, tho the pruning which they receive should be directed at thinning out unproductive wood and cutting back to outside lateral growths. In combination with nitrogen applications this procedure should renew the vigor of the trees and either maintain or increase production.

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