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TWENTY-FIVE YEARS OF FERTILIZERS IN A NEW YORK APPLE ORCHARD

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U. P. HEDRICK AND H. B. TUKEY

SUMMARY

These are the results of 25 years of fertilizers in a New York apple orchard under a system of clean cultivation and nonleguminous cover-cropping.

The orchard, 28 years old, is located on a Dunkirk clay loam, slightly heavier than the best New York apple land. The variety is Rome Beauty, budded on Ben Davis. The trees were selected with strict attention to uniformity.

The experiment consists of 12 plats of 5 trees each. Four plats receive no treatment, and the remaining 8 receive 4 different treatments in duplicates.

Fertilizers have been applied since the fall of 1899 at the following rates per acre:

Plats 1 and 9—11,200 pounds of stable manure.
Plats 2 and 8—340 pounds of acid phosphate.
Plats 6 and 10—340 pounds of acid phosphate.
196 pounds of muriate of potash.
Plats 4 and 12—100 pounds of nitrate of soda.
346 pounds of dried blood.
340 pounds of acid phosphate.
196 pounds of muriate of potash.
Plats 3, 5, 7, and 11—Checks, no treatment.

A nonleguminous cover crop has been sown annually and the orchard kept in good tilth.

Records have been kept of growth, size, and yield of fruit, and of such miscellaneous factors as color of foliage and quality, maturity, keeping quality, and color of fruit.

The application of fertilizers has resulted in no consistent differences either in total yield of fruit, size, color, date of maturity, flavor, texture, or keeping quality.

There has been a tendency for the trees to produce the same proportion of fruit grading 2½ inches and above, in spite of differences in yield, growth, or fertilizer applications.

One of the most reliable indexes of tree performance is trunk diameter. In this measurement all plat treatments approach a common

average, fluctuating slightly about the check as a common center. The trees receiving manure average 0.08 of an inch smaller than those receiving no fertilizer, while those receiving a complete fertilizer are 0.06 of an inch larger.

The plats which have the large trees have also been the high-producing plats, as well as the plats leading in yield of fruit 2½ inches and above.

Measurements of growth made in 1899, before any fertilizers had been applied, indicated differences in vigor of trees. The ranking of the plats at that time approaches closely the ranking in 1923. The treatments which have given the largest yields, the largest yields of fruit ranging 2½ inches and above, and the biggest trees, were, by actual measurement, the most vigorous 25 years ago, before an ounce of fertilizer had been applied. The various fertilizer treatments, have failed to alter the direction in which the plats were headed before they received these different treatments.

High or low individual tree performance has not been a matter of bud variation. The importance, however, of securing the best and most vigorous trees possible for orchard planting is emphasized.

The trend of this experiment has not been appreciably altered by the 13 additional harvests since 1910.

The practical outcome of the fertilizer test is that in the average western New York apple orchard that is well cultivated, properly drained, and sufficiently supplied with organic matter and humus by means of a cover crop commercial fertilizers are not needed.

A plan for a fruit grower's fertilizer test is suggested.

INTRODUCTION

THE PROBLEM

In 1910 the question of the use of fertilizers in apple orchards was asked and answered in a publication from this Station[1] recording the 15-year results in fertilizing an apple orchard. At that time the statement was made that "the trees in this experiment would have been practically as well off had not an ounce of fertilizer been applied to them." Again, in 1918, with the data from 8 additional harvests, 15 in all, the subject was once more attacked. This time it was said,[2]

[1]Hedrick, U. P. Is it necessary to fertilize the apple orchard? *New York Agr. Exp. Sta. Bul. No. 339. 1911.*

[2]Hedrick, U. P., and Anthony, R. D. Twenty years of fertilizers in an apple orchard. *New York Agr. Exp. Sta. Bul. No. 460. 1919.*

"If the results continue in the present direction for another ten years, the increased yields may justify the recommendation of one or two of the treatments, but at present this cannot be done." Now, in 1923, with the records of 20 harvests, whose total yields are more than one hundred times those recorded when the first publication was issued, a third, and perhaps final, attempt is made to answer the question to which the orchard has been devoted since it was planted 28 seasons ago.

There is today almost as much diversity of opinion regarding the fertilizing of apple orchards as there was 30 years ago when the plans for this experiment were first made. Not only are the practical orchardists and fruit growers entirely at a loss, but the recommendations of experts thruout the country differ so widely at times that they seem inharmonious and irreconcilable. It may not be amiss, therefore, to review very briefly the reports from other sections before beginning a discussion of the present work with fertilizers.

REPORTS FROM OTHER SECTIONS

In the first place, fertilizer studies on the Pacific Coast, namely in the state of Washington,[3] have indicated that no form of commercial fertilizers are of value except when used in orchards the growth of which is unsatisfactory or in which cover crops have been established. In Kansas the beneficial effect of manure has been ascribed to the preservation of moisture during periods of drouth,[4] while in the Ozark regions fertilizers have increased the set of fruit on poor leachy soils and have assisted in carrying the crop thru, tho on fertile soils the response has not been large.[5] From Indiana it has been reported that nitrate of soda has little effect in orchards under cultivation.[6] West Virginia has been led to the conclusion that the average well-cared-for orchard is not apt to respond to fertilizers,[7] while her neighbor, Virginia, has reported that cultural treatments are more effective than fertilizer applications.[8] Pennsylvania has stated that "trees under cultivation have not shown a profitable return from the addition of fertilizers when a good cover crop was grown."[9] New Hampshire has

[3] *Washington College Sta. Bul. No. 175, 31. 1922.*

[4] *Kansas Agr. Exp. Sta. Rpt., 1919, 37.*

[5] Cooper, J. R. Preliminary report on the effect of fertilizer in apple orchards in the Ozark region. *Amer. Soc. Hort. Sci.* **17**, *190–193. 1920.*

[6] *Indiana Agr. Exp. Sta. Rpt. 1920, 27.*

[7] Alderman, W. H. and Crane, H. L. The fertilization of apple orchards. *West Virginia Agr. Exp. Sta. Bul. No. 174, 1920.*

[8] *Virginia Agr. Exp. Sta. Rpt., 1919, 8–10.*

[9] Anthony, R. D. and Waring, J. H. Methods of interpreting yield records in apple fertilization experiments. *Pennsylvania Agr. Exp. Bul. No. 173. 1922.*

found no cash returns from money invested in fertilizers in a Baldwin apple orchard under cultivation,[10] and results of fertilizer treatments in England[11] have indicated no favorable response to manurial dressings.

On the other hand, nitrogen has been responsible for increased yields in Delaware, tho increased applications have not been commensurate with resulting yields.[12] The combination of cover crops and nitrate has resulted in increased yields in Oregon;[13] and in Ohio,[14] on land low in fertility, nitrogenous fertilizers have produced a marked effect. Fertilization in Michigan "has not yet made good trees into super-trees, but it has made poor trees good or kept good trees from becoming poor."[15]

In general it can be said from these results reported from various sections of the country, contradictory as some of them may seem, that fertilizers are, in the main, held to be of value on thin or worn out land or in orchards which are making weak growth. At the same time, well-cared-for orchards on good land, under proper methods of clean cultivation and cover cropping, show little favorable response to fertilizer applications.

If sod orchards were to be considered in this connection, it would be apparent at once that there is hardly a single exception to the general rule that sod orchards respond markedly to nitrogenous fertilizers.

INVESTIGATION

SITE AND SOIL

The experimental orchard stands on soil that is classified as heavy Dunkirk clay loam from 12 to 18 inches deep, with a still heavier clay subsoil, lying a mile and a half west of Seneca Lake at an elevation of 100 feet above the lake and 550 feet above the sea. It is a level,

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[10]Gourley, J. H. Sod, tillage, and fertilizers for the apple orchard. A ten-year summary. *New Hampshire Agr. Exp. Sta. Bul. No. 190. 1919.*

[11]*Woburn Exp. Fruit Farm. 4th & 5th Rpt. 1904–05.*

[12]*Delaware Agr. Exp. Sta. Bul. No. 129, 15–16. 1921.*

[13]Brown, G. G. Hood River apple orchard management with special reference to yields, grades, and value of fruits. *Oregon Agr. Exp. Sta. Bul. No. 181. 1921.*

[14]Ballou, F. H. Orchard rejuvination in southeastern Ohio (Second Report). *Ohio Agr. Exp. Sta. Bul. No. 339. 1920.*

[15]Bradford, F. C. Nitrogen-carrying fertilizers and the bearing habits of mature apple trees. *Michigan Agr. Exp. Sta. Sp. Bul. No. 127. 1924.*

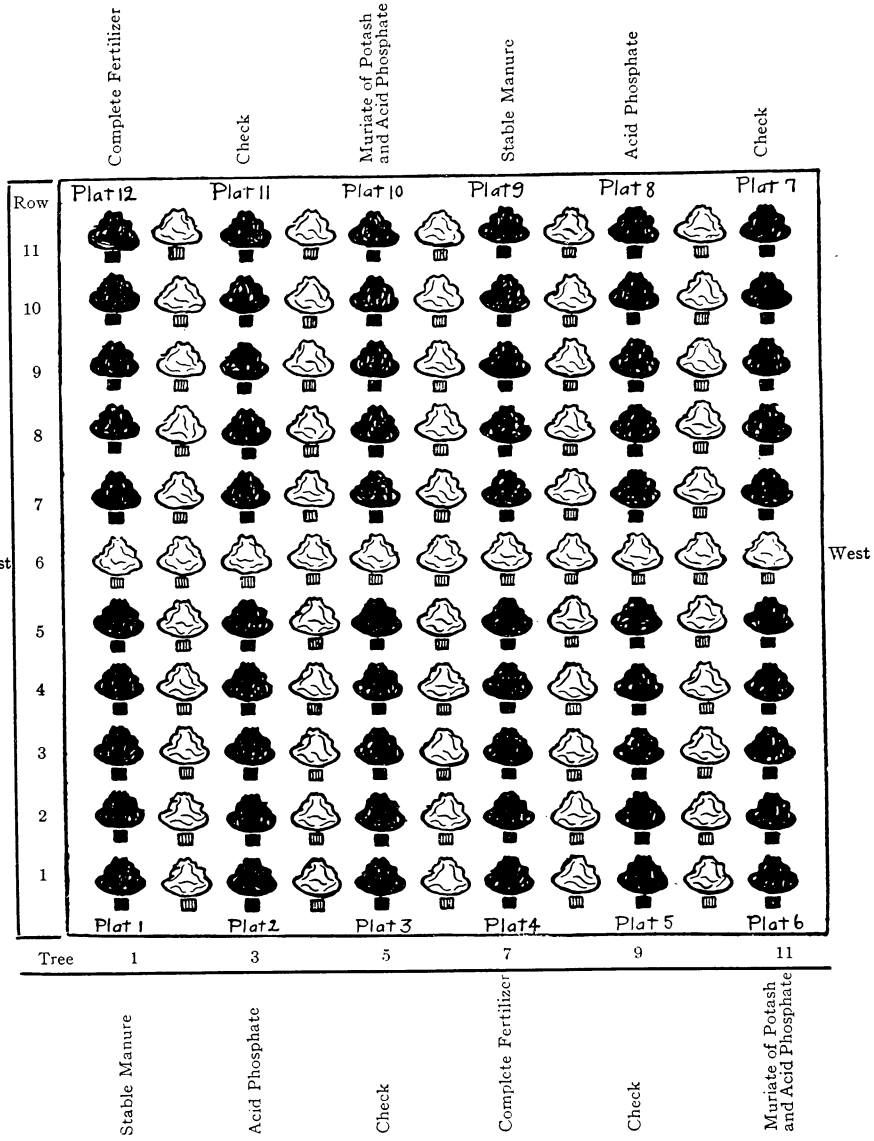

FIG. 1.—PLAN OF ORCHARD AND TREATMENT OF PLATS.

well-drained piece, noted for years for its uniformly high production of general farm crops, tho it is too heavy for what might be called ideal orchard soil.

PLATS AND FERTILIZERS

The plats, 12 in number, consist each of five trees set 40 feet apart each way. Division or buffer rows, which are not included in the test, divide the plats, so that the trees in different treatments are separated by a distance of 80 feet. The treatments are four in number, as shown in Table 1, and the applications are such as are there recorded. It must be mentioned in passing that the fertilizers were applied not over the *entire area* of the plats but over an area slightly larger than that covered by the branches of the individual trees, as is the common orchard practice. When it is remembered that the amounts applied at present were also applied even when the trees were small, it will be recognized that heavy applications have been made.

The treatments are in duplicate, with the exception of the checks, of which there are four, and are so arranged as to place similar treatments as far apart as possible. The general arrangement is shown in Fig. 1.

The first application of fertilizers was made in the fall of 1899, and they have since been applied between the fifteenth of May and the fifth of June of each year of the experiment.

TABLE 1.—AMOUNTS OF MATERIALS ANNUALLY APPLIED IN ORCHARD FERTILIZER EXPERIMENT.

TREATMENT	PLATS	POUNDS PER ACRE	PLANT FOOD PER ACRE		
			N	P_2O_5	K_2O
Checks	3, 5, 7, 11				
Stable manure	1, 9	11,200	50	30	50
Complete fertilizer	4, 12	196 muriate of potash			100
		340 acid phosphate		50	
		100 nitrate of soda, 346 dried blood	50		
Phosphoric acid and potash	6, 10	196 muriate of potash			100
		340 acid phosphate		50	
Phosphoric acid	2, 8	340 acid phosphate		50	

THE TREES

Every effort was made to secure uniform trees and to guard against any possibilities of the effect of stock on cion or of variation in buds. One hundred 3-year-old Ben Davis trees, as nearly alike as possible, were selected from a large nursery block by the experienced foreman of one of the large nurseries in the vicinity, and, from this lot, 60 were finally chosen as the most uniform and planted in the experimental orchard. Rome Beauty, similar in many respects to Ben Davis, was chosen as the variety with which to top-bud the trees. Moreover, the buds were all taken from the same tree.

MANAGEMENT OF THE ORCHARD

The orchard has been clean cultivated thruout its life, beginning with an early spring or late fall plowing and followed by such cultivations as necessary to keep it clean until the last of July or first of August, when nonleguminous cover crops have been sown. The cover crops, together with the year in which each was grown, are listed in Table 2.

The first nine years the orchard was interplanted with peaches and, while it was very young, several crops of grain were taken from the land, yet the tree rows were maintained in clean cultivation.

Spraying experiments have been conducted in the orchard, tho in such a manner as to interfere in no way with the fertilizer work.

The fruit has been graded over a mechanical sizer into three sizes, namely, "Firsts," 2½ inches in diameter and above; "Seconds," from 2¼ to 2½ inches in diameter; and "Culls," below 2¼ inches. The object thruout, in the management of the orchard has been to follow recognized commercial practices so far as possible.

TABLE 2.—COVER CROPS IN EXPERIMENTAL ORCHARD.

CROP	YEAR
Rape	1896, 1918, 1919
Wheat	1897
Rye	1898, 1899, 1900, 1901, 1902, 1904, 1908
Oats	1903, 1907, 1921
Barley	1905, 1906, 1915, 1920, 1922, 1923
Rape and Cowhorn turnip	1909, 1914, 1916, 1917
Barley and Cowhorn turnip	1910, 1911
Buckwheat	1912
Barley and oats	1913

MEASUREMENT OF RESULTS

Besides yearly records of yield and size of fruit as noted in the preceding paragraph, measurements have been made at frequent intervals of increases in trunk diameter, one of the most reliable and useful indexes of the performance of trees, the average being taken of the measurements at 1 foot and 3 feet above the ground. Any differences in color or quality of fruit, in color or nature of foliage, or in date of maturity or keeping quality of fruit have been carefully sought.

RESULTS OF FERTILIZER APPLICATIONS

Before discussing the results of the fertilizer treatments it may be well to point out some of the uncontrollable factors, which creep into every experiment sooner or later, and which may have some effect upon the final interpretation of the results. It has been shown that, as fertilizer experiments run, there exists a high degree of uniformity or correlation in the orchard under discussion,[16] a fact which reflects the pains used by the late Professor S. A. Beach in selecting the site and in watchfully eliminating as many sources of variability as possible.

Nevertheless, the southwest corner of the orchard, which lies in a small depression, has produced uniformly poor growth so that Plat 7, one of the four check plats, has been thrown out of the experiment since early in the life of the orchard, and Plat 8 has been somewhat, tho very slightly, affected. On the other hand, in the southeast quarter of the orchard, there is a region of high productivity, due possibly to a relatively high proportion of clay and affecting both Plats 11 and 12. In Plat 9 one tree (tree 7, row 11) has died, the fourth tree in Plat 5 has a dead area in the lower trunk, and the fifth tree in Plat 10 has a large canker on one side of the trunk. Moreover, in the summer of 1922, the top of the first tree in Plat 12 was slightly burned when a sulfur duster took fire and ignited a canvas covering used to protect the tree from the dust. Yet these misfortunes are certainly no more than to be expected in the average orchard which has been set for 28 years.

[16]Hedrick, U. P. and Anthony, R. D. Twenty years of fertilizers in an apple orchard. *New York Agr. Exp. Sta. Bul. No. 460. 1919.*

Anthony, R. D. and Waring, J. H. Methods of interpreting yield records in apple fertilization experiments. *Pennsylvania Agr. Exp. Sta. Bul. No. 173. 1922.*

Batchelor, L. D. and Reed, H. S. Relation of the variability of yields of fruit trees to the accuracy of field trials. *Jour. Agr. Res.* **12**, *245. 1918.*

Nor have we attempted any of the modern statistical methods, since in 1919 the subject was treated very thoroly from that angle. Moreover, the figures are very clear without resort to mathematical niceties.

EFFECT UPON THE FRUIT

Yield of fruit.—Yield is a poor yardstick by which to measure responses, for it fluctuates widely with adverse weather conditions of short duration, such as frost, hail, and wind. Growth measurements are much more reliable, yet since yield is of first importance in apple production, it must be fully considered. Table 3 gives the total yield by plats and treatments for the entire 20 harvests. In the appendix will be found the yields for the individual trees from 1919 to 1923, while in Bulletins Nos. 339 and 460, which treat of this experiment earlier in its history, are similar records for all previous years.

From a hasty glance at the tables one might be misled into the opinion that the application of potash had resulted in increased yields, reasoning that since the phosphoric acid and potash plats are the highest in yield and since the phosphoric acid plats are the lowest, that the increases in the former must be due to what is lacking from

TABLE 3.—INFLUENCE OF TREATMENT ON YIELD OF FRUIT IN ORCHARD FERTILIZER EXPERIMENT, 1902 TO 1923.

Total and Average Yield per Plat and Treatment in Pounds.

PLAT	TREATMENT	YIELD	YIELD PER TREE	RANK	TREATMENT YIELD PER TREE	RANK
1.....	Stable manure..	41,583	8,316	5	7,834	4
9 (4 trees).	Stable manure.	29,425	7,353	10		
2.....	Phosphoric acid	38,322	7,664	8	7,149	5
8.....	Phosphoric acid	33,178	6,635	11		
6.....	Phosphoric acid and potash...	46,495	9,299	1	9,088	1
10.....	Phosphoric acid and potash...	44,386	8,877	3		
4.....	Complete fertilizer	46,133	9,226	2	8,719	2
12.....	Complete fertilizer	41,063	8,212	6		
3.....	Check.....	41,695	8,339	4	7,969	3
5.....	Check.....	36,846	7,369	9		
11.....	Check.....	40,995	8,199	7		
		1917 TO 1923				
7.....	Check.....	12,103	2,420	.....	.....	.....

the latter. Likewise, it would be assumed that the application of stable manure has actually decreased the yield, and that phosphoric acid has done the same.

But a consideration of the other plats for a moment will dispel these illusions. In the first place, it may be pointed out that the plats receiving the complete fertilizer receive not only the same amount of potash and phosphoric acid as do the highest yielding plats but also 50 pounds of nitrogen in addition. Yet the complete fertilizer plats are inferior, tho only slightly to be sure, to those receiving phosphoric acid and potash! Likewise, the manure plats—tho receiving not only half as much potash as the two leading treatments and more than half as much phosphoric acid but also an application of nitrogen equal to that given the complete fertilizer plats—are inferior not only to plats receiving somewhat similar treatment, but are also actually poorer than the checks. Phosphoric acid when applied singly has seemingly also decreased the yield, so that two treatments appear superior to the checks and two treatments appear inferior, while the checks stand squarely between.

A consideration of Table 4 in conjunction with Table 3 will further clear the issue. Here it will be noticed that the plats which led in production for the entire period of study also led during the three periods into which the life of the orchard has been arbitrarily divided, while the low-producing plats have retained similar relations. In fact, this relation between plats as brought out in the ranking of the plats in Table 4 runs thruout the experiment with remarkable uniformity. That is to say, that from the measurements of yields made at any time during the life of the orchard between 1910, when the total yield was less than one-hundredth what it now is, and 1923, it will be found that there are certain plats outstandingly high yielders and certain plats outstandingly low yielders, and that this relationship has persisted.

All that can be said in conclusion is that there are differences in total production which have continued in much the same proportion from the first period of harvest until the last, and that these differences arrive at no consistent conclusion regarding any benefits from fertilizer applications. Fortunately, however, there are other measurements which will throw light upon the interpretation of the data for yields, but they must be left until the discussion of growth.

Size of fruit.—In 1910 it was said that "this harvest possibly shows an influence of the fertilizer. . . .The differences, however, are very

slight and unless future crops show the same falling off in size for the checks, increased size must not be counted as an asset for the fertilizers in the experiment up to the present, but rather as an

TABLE 4.—RANK OF PLATS IN ORCHARD FERTILIZER EXPERIMENT IN YIELD OF FRUIT PER TREE.

PLAT	TREATMENT	RANK			
		1902–1910	1911–1918	1919–1923	1902–1923
1	Stable manure...	3	3	7	5
9	Stable manure...	10	9	9	10
2	Phosphoric acid..	6	6	10	8
8	Phosphoric acid..	11	11	11	11
6	Phosphoric acid and potash...	2	2	1	1
10	Phosphoric acid and potash....	5	4	2	3
4	Complete fertilizer.....	1	1	3	2
12	Complete fertilizer	8	7	5	6
3	Check.....	4	5	6	4
5	Check.....	9	10	8	9
11	Check.....	7	8	4	7
1 and 9	Stable manure...	4	3	4	4
2 and 8	Phosphoric acid..	5	5	5	5
6 and 10	Phosphoric acid and potash....	1	1	1	1
4 and 12	Complete fertilizer	2	2	2	2
3, 5, and 11	Check.....	3	4	3	3

accidental variation." Now after 13 additional harvests it can be definitely stated that if there is any favorable effect upon size, it is so small that it is not worth considering as a benefit from fertilizer applications.

The striking point in looking at Table 5, which records the influence of the treatments upon the size of the fruit, is the approach to uniformity of the average for all treatments in spite of the differences in yields. Altho the differences between treatment yields have ranged as high as 25.3 per cent, yet the range in percentage of "firsts" is but 4.6. As an illustration, the application of phosphoric acid apparently reduced the yield 11.3 per cent, tho it added *one more apple per hundred* to the class of "firsts." On the other hand, merely the addition of potash to the phosphoric acid fertilizer apparently increased the yield 14.0 per cent and also increased the percentage of "firsts" 4.6 per cent. *Such slight differences indicate but one thing,*

TABLE 5.—INFLUENCE OF TREATMENT ON SIZE OF FRUIT IN ORCHARD FERTILIZER EXPERIMENT.

Pounds of Fruit Grading 2½ Inches or Over, 1902 to 1923.

PLAT	TREATMENT	TOTAL 2½ IN. OR OVER	TOTAL 2½ IN. OR OVER PER TREE	TOTAL YIELD PER TREE	PERCENTAGE 2½ IN. OR OVER	RANK	TREATMENT TOTAL 2½ IN. OR OVER	TREATMENT TOTAL YIELD PER TREE	TREATMENT PERCENTAGE 2½ IN. OR OVER	RANK
1	Stable manure	30,841	6,168	8,316	74.1	4				
9	Stable manure (4 trees)	19,742	4,935	7,353	67.1	10	5,551	7,834	70.8	3
2	Phosphoric acid	26,349	5,269	7,664	68.7	6				
8	Phosphoric acid	23,759	4,751	6,635	71.6	5	5,010	7,149	70.0	4
6	Phosphoric acid and potash	36,475	7,295	9,299	78.4	1				
10	Phosphoric acid and potash	30,420	6,084	8,877	68.5	7	6,689	9,088	73.6	1
4	Complete fertilizer	34,920	6,984	9,226	75.6	2				
12	Complete fertilizer	27,819	5,563	8,212	67.7	9	6,273	8,719	71.9	2
3	Check	28,436	5,687	8,339	68.1	8				
5	Check	27,713	5,542	7,369	75.2	3	5,506	7,969	69.0	5
11	Check	26,447	5,289	8,199	64.5	11				

TABLE 6.—RANK OF PLATS IN ORCHARD FERTILIZER EXPERIMENT IN YIELD PER TREE OF FRUIT GRADING 2½ INCHES OR OVER.

PLATS	TREATMENT	1902–10	1911–18	1919–23	1902–23
1	Stable manure	2	3	5	3
9	Stable manure	10	8	11	10
2	Phosphoric acid	6	6	10	9
8	Phosphoric acid	11	11	9	11
6	Phosphoric acid and potash	3	2	1	1
10	Phosphoric acid and potash	5	4	3	4
4	Complete fertilizer	1	1	2	2
12	Complete fertilizer	8	7	6	6
3	Check	4	5	7	5
5	Check	9	10	4	7
11	Check	7	9	8	8
1 and 9	Stable manure	3	3	4	3
2 and 8	Phosphoric acid	5	5	5	5
6 and 10	Phosphoric acid and potash	1	1	1	1
4 and 12	Complete fertilizer	2	2	2	2
3, 5, and 11	Check	4	4	3	4

namely, the tendency for the trees to produce the same proportion of fruit grading 2½ inches or above in spite of differences in yield, growth, or fertilizer applications.

Again it will be observed from Table 6 that just as there is a relationship in yield between plats from the beginning of the experiment to the present time, so there is a relationship in production of "firsts." Plats which produced a high yield of "firsts" from 1902 to 1910 did likewise from 1911 to 1918, and again from 1919 to 1923, while the same relation holds for the plats producing a low yield of "firsts."

Still another interesting fact is that there is a high degree of correlation between total yield, yield of "firsts," and proportion of "firsts." The treatments that produced the largest crops, not only tended to produce the greatest number of fruits grading 2½ inches and over but also tended to yield the highest proportion of that grade. It might be expected that the proportion of large fruit would be smaller on trees producing heavy yields and higher on trees producing low yields. An explanation for this behavior was made in 1919 in Bulletin No. 460, where it was stated that, "it should be borne in mind that Rome is a variety which seldom overloads and so, even with large yields, each apple gets a chance to reach normal size. With other varieties, we should probably find a marked tendency for the size of fruit to decrease with large yields."

Color of fruit.—Since every opportunity was given in the planning of the experiment to increase any color variations that might occur, they should be easily detected here. Repeated examinations of the fruit on the trees and on the sorting tables year after year by several individuals have resulted in nothing but the constant repetition of "no differences in color." It is a common opinion that potash heightens color and that forms of nitrogen lessen it, yet there is nothing whatsoever to show that the color of the fruit in this orchard has been affected in any way by any of the fertilizer applications.

Other fruit characters.—It has been shown in the case of cherries that fertilizers may have some effect upon the composition of the fruit. In the case in mind the application of complete fertilizer increased the amount of flesh and sugar and decreased the amount of acids.[17] No such test has been made in regard to the effect of fertilizer upon the flavor and texture of the apples in this experiment, but it can be said with finality that no differences in either respect

[17]Kochs. The effects of fertilizers on the composition of cherries. *Landw. Jahrb.* **56**, *Er. 1, 67–69, 1921.*

have been detected by ordinary methods of observation. Neither has the time of maturity nor the keeping quality been affected.

EFFECT UPON THE GROWTH OF THE TREES

Increase in trunk diameters.—When we consider the effect of fertilizers upon the growth of the trees, we consider probably the most reliable index of tree performance; and when we consider trunk diameters, we consider the most accurate measurements of growth,[18] for in the "rings" of annual growth the tree has itself recorded its own history. It is upon these figures that most reliance is here placed. The plat averages of trunk measurements taken in 1905, 1910, 1918, and 1923 will be found in Table 7, together with the rank of the plats for those years.

Since the trees were of the same size when planted, the measurements of 1923 indicate the total increases made during 28 years. Now, if averages are permissable, the largest trees are on the plats receiving phosphoric acid and potash and the smallest on the plats receiving phosphoric acid alone. The check plats, once more, stand squarely in the middle flanked on one side by complete fertilizer plats with trees 0.06 of an inch larger and on the other by manure plats with trees 0.08 of an inch smaller. So that if there be any who desire the figures to speak for themselves the figures will say, "the application of complete fertilizers for 24 years has increased the diameter of trees 0.06 of one inch over those receiving no treatment whatsoever, and, the application of manure, in itself a complete fertilizer, has actually decreased the diameter of trees 0.08 of one inch!" Surely these would be meager figures upon which to base fertilizer recommendations. A more rational view is that all plat treatments approach a common average, fluctuating slightly about the check as a common center.

If cognizance be taken of the ranking of plats and treatments according to growth measurements as shown in Table 7, the same peculiar tendency will be noticed as was found in total yield of fruit, yield of "firsts," and proportion of "firsts," *viz.*, a tendency for the large-tree plats to have maintained that relation from 1905, when measurements were first made, thru 1910 and 1918, and finally closing with

[18] Waring, J. H. The probable value of trunk circumference as an adjunct to fruit yields in interpreting apple orchard experiments. *Amer. Soc. Hort. Sci.* **17,** *179–185. 1920.*

1923. Likewise, the small-tree plats have done the same and those intermediate have reacted in a similar direction.

TABLE 7.—TRUNK DIAMETERS IN ORCHARD FERTILIZER TEST.

PLAT	TREATMENT	TRUNK DIAMETER IN INS.				RANK			
		1905	1910	1918	1923	1905	1910	1918	1923
1	Stable manure...	3.98	6.40	9.5	11.14	2	2	5	3
9	Stable manure...	3.71	6.12	9.7	10.38	8	7	3	10
2	Phosphoric acid	3.82	6.31	9.6	10.77	5	4	4	7
8	Phosphoric acid	3.37	5.66	9.2	10.23	11	11	8	11
6	Phosphoric acid and potash...	4.00	6.55	10.2	12.05	1	1	1	1
10	Phosphoric acid and potash...	3.72	6.14	9.4	11.08	7	6	7	4
4	Complete fertilizer.....	3.92	6.39	9.8	11.47	4	3	2	2
12	Complete fertilizer.....	3.78	5.97	8.1	10.34	6	10	11	9
3	Check.....	3.97	6.25	9.5	10.93	3	5	6	6
5	Check.....	3.58	6.10	9.0	11.06	10	8	9	5
11	Check.....	3.63	6.06	8.7	10.54	9	9	10	8
1 and 9	Stable manure...	3.85	6.26	9.45	10.76	2	2	2	4
2 and 8	Phosphoric acid	3.58	5.98	8.85	10.50	5	5	5	5
6 and 10	Phosphoric acid and potash...	3.86	6.35	9.95	11.56	1	1	1	1
4 and 12	Complete fertilizer.....	3.75	6.18	9.40	10.90	3	3	3	2
3, 5, and 11	Check	3.73	6.14	9.23	10.84	4	4	4	3

Other measurements of growth.—At one time measurements were made of the weights of leaves and of the lengths of twig growths, but no differences could be observed after 15 years of fertilizer applications[19] and further efforts along these lines were discontinued.

It is common knowledge, however, that where nitrogen applications meet with response color changes in the foliage are quickly seen, often within two or three weeks after application.[20] Moreover, the foliage frequently retains its green color later in the season and hangs longer to the tree. There has been no appreciable effect upon either the color or character of the foliage at any time during any of the 24 seasons that fertilizers have been applied.

A comparison of the plats before and after treatment.—We are now led to a most interesting subject, namely, the relative vigor of the trees before an ounce of fertilizers was applied. It will be recalled that the

[19]Hedrick, U. P. Is it necessary to fertilize an apple orchard? *New York Agr. Exp. Sta. Bul. No. 339. 1911.*

[20]*Pennsylvania Agr. Exp. Sta. Bul. No. 176. 19–21. 1922.*

trees were planted in 1896, but that no fertilizer applications were made until the fall of 1899. The first four seasons of growth were, therefore, uninfluenced by fertilizer treatment. It will also be recalled that there were differences in fruit production between different treatments as early as 1910 which have remained in the same relation to each other as they then were, and that, as early as 1905, there were differences in growth as measured by trunk diameter which have been maintained consistently year after year up to the present time. But these measurements were made after fertilizers had been applied for several years, so that there is no way of disproving that the uniform relation between plats has not been the result of the treatments that they have been receiving.

Fortunately, records were kept in the early life of the orchard and the measurements of relative vigor and of average terminal growth taken in 1899, before a particle of fertilizer had been applied, are to be seen in Table 8. At that time the trunk diameters were still so small that such measurements would have had little or no significance. On the other hand the measurements of average terminal growth should be of great importance in indicating the relative vigor of the trees before it can be seen in trunk diameters. It will at once be noted that there were differences in vigor apparent as early as four years after planting—and this in spite of the great pains used in selecting uniform trees, as told in the fore part of this publication, and in spite of the fact that no fertilizers had been applied.

The most striking thing of all, however, is that *the rank of the plats in 1899, before an ounce of fertilizer had been applied, approaches closely the rank in 1923 after 24 years of liberal fertilizer applications.* The various fertilizer treatments have seemingly failed to alter the direction in which the plats were headed before they received these different treatments.

The plats best in one respect have been best in all.—It has already been remarked that growth is a good indication of the performance of the tree. No better illustration could be found of this fact than in the orchard under discussion. Table 9 gives the relation between growth, yield, and size of fruit, in which it may be seen that the plats which have the large trees have also been the high-producing plats as well as the plats leading in yield of fruit 2½ inches and above. This relation holds exactly for the averages of the plats receiving the same treatments with the exception of the yield of "firsts," where third and fourth rank are separated by differences of 0.8 per cent.

TABLE 8.—COMPARISON OF RELATIVE VIGOR OF TREES IN 1899, BEFORE FERTILIZERS WERE APPLIED, WITH TRUNK DIAMETERS IN 1923 AFTER 24 YEARS' APPLICATIONS.

PLAT	TREATMENT	MEASUREMENTS IN INS.			RANK		
		RELATIVE VIGOR 1899	AVERAGE TERMINAL GROWTH 1899	AVERAGE TRUNK DIAMETER 1923	RELATIVE VIGOR 1899	AVERAGE TERMINAL GROWTH 1899	AVERAGE TRUNK DIAMETER 1923
1	Stable manure..	89	35.2	11.14	11	6	3
9	Stable manure..	95	35.2	10.38	1-3	7	10
2	Phosphoric acid	95	38.4	10.77	1-3	1	7
8	Phosphoric acid	91	33.0	10.23	10	11	11
6	Phosphoric acid and potash...	94	38.2	12.05	4-5	2	1
10	Phosphoric acid and potash...	95	34.4	11.08	1-3	8	4
4	Complete fertilizer.....	93	35.8	11.47	6-9	5	2
12	Complete fertilizer.....	93	33.4	10.34	6-9	10	9
3	Check.....	93	36.0	10.93	6-9	4	6
5	Check.....	94	38.0	11.06	4-5	3	5
11	Check.....	93	33.4	10.54	6-9	9	8
7	Check	87	31.0	9.43	12	12	12
1 and 9	Stable manure...	92	35.2	10.76	5	4	4
2 and 8	Phosphoric acid	93	35.6	10.50	3-4	3	5
6 and 10	Phosphoric acid and potash...	94.5	36.2	11.56	1	1	1
4 and 12	Complete fertilizer.....	93	34.6	10.90	3-4	5	2
3, 5, and 11	Check.....	93.3	35.8	10.84	2	2	3

TABLE 9.—RELATION OF GROWTH, YIELD, AND SIZE OF FRUIT IN ORCHARD FERTILIZER EXPERIMENT.

PLAT	TREATMENT	TRUNK DIAMETER, INCHES	YIELD PER TREE, POUNDS	YIELD OF "FIRSTS" PER TREE, POUNDS	RANK		
					Trunk diameter	Yield per tree	Yield of 'firsts' per tree
1 and 9	Stable manure...	10.76	7,834	5,551	4	4	3*
2 and 8	Phosphoric acid	10.50	7,149	5,010	5	5	5
6 and 10	Phosphoric acid and potash...	11.56	9,088	6,689	1	1	1
4 and 12	Complete fertilizer.....	10.90	8,719	6,273	2	2	2
3, 5, and 11	Check.....	10.84	7,969	5,506	3	3	4*

*45 pounds separating these two.

Since the plats averaging the most growth are also those of highest yield and highest production of "firsts," and since these plats showed the same growth relations before any fertilizers were applied, it can be said with finality that fertilizers have had no effect upon the trees in any way, but that any differences which have appeared have been due to factors other than fertilizer treatment which were present before fertilizers were applied.

Is individual performance a matter of bud variation?—It is only natural that this question should be asked, for if the high performance of some trees and the low performance of others is not due to fertilizer treatments, if the trees were selected with regard to uniformity, and if the soil is uniform, then to what are the differences due if not to variations in the bud? Fortunately, again, a decisive answer can be given. In the first place, it will be recalled, the buds used in top-budding the orchard were all taken from the same Rome Beauty tree, thus eliminating any possibility of different strains of this variety entering into the experiment. In the second place, an experiment has been running since 1912 to determine this very point.

Two rows of Northern Spy-rooted cuttings were set 20 feet apart with the trees 20 feet apart in the row, and 12 of them were budded from each of 5 of the most productive Rome Beauty trees in the orchard and 12 from each of 5 of the least productive. Thus, one row of 60 trees propagated from productive trees was paralled by a row of 60 trees propagated from unproductive trees. Under these conditions, identical in soil, stock, and treatment, not one particle of difference has arisen; the "high-yielding" trees are no better than the "low," and the "low-yielding" trees are no better than the "high."

The discussion resolves itself naturally, therefore, into one of stocks for apple trees, a subject about which little is now known but concerning which much may be expected in the future. The importance, however, of securing the best and most vigorous trees possible for orchard planting is stressed by this investigation.

SUMMARY OF RESULTS

When we come to summarize the effects of the fertilizer treatments in the orchard, we are forced to conclude that they have made absolutely no impression upon the behavior of the trees. We find the orchard to be unusually uniform in both soil and trees. We find differences in yield of fruit, but neither large differences, consistent differ-

ences, nor differences that may be attributed to the treatments themselves. We find no differences in color, flavor, texture, keeping quality, or time of maturity of the fruit. We find differences in the proportions of "firsts," but differences so slight, in view of the larger differences in yield, that they rather support the opinion that there has been no effect due to fertilizers. We find differences in growth, but differences again so slight that they must be measured in the hundredth parts of an inch and which group themselves evenly about the untreated plats as a center. We find no differences in the size or color of the foliage. And, finally, and possibly most important of all, we find that the differences which do exist, small tho they are, were present in somewhat the same degree before any fertilizer applications whatsoever had been made.

Moreover, the results apparent in 1910 have not been appreciably affected by 13 additional seasons, indicating the lack of necessity for carrying on long-time fertilizer experiments with apple trees once the trend of the experiment has been established.

PRACTICAL OUTCOME OF THIS EXPERIMENT

"Is it necessary to fertilize an apple orchard?" was asked in 1911. The answer made by this experiment at that time is similar to the one made now: In the average western New York apple orchard that is well cultivated, properly drained, and sufficiently supplied with organic matter and humus by means of a cover crop, commercial fertilizers are not needed. In sod orchards it has been shown repeatedly that nitrogen-carrying fertilizers are beneficial and that the results are measurable in hundreds of per cent instead of in tenths of 1 per cent. Whether orchards on land that is sandy, gravelly, low in fertility, drouthy, or shallow may respond to fertilizer applications must be answered by fertilizer tests under such conditions—they cannot be answered by this experiment. The point is that in *this* orchard, which is representative of dozens of others in western New York, the application of commercial fertilizers has been a waste of both time and money.

How, then, can the grower determine the needs of his orchard? If the trees are in a healthy condition, well cared for, and bearing well, there is no reason to expect them to require fertilizers. In orchards that are run down or which are making only a few inches of growth attention should first be given to drainage, cultivation, and

general orchard practices, which may be just as effective as the use of commercial fertilizers and far less expensive. It may even be that certain trees in the orchard may respond when others may not. The question is one that each orchardist must answer for himself, helped in formulating his answer, we hope, by the findings in this experimental orchard and by the suggestions made herein.

A FRUIT GROWER'S FERTILIZER TEST

If there is any doubt as to the plant food requirements of the orchard, the grower should conduct a test of his own. There are innumerable combinations of fertilizers that may be made. Treatments consisting of all possible combinations of the three materials most commonly deficient, namely, nitrogen, phosphorus, and potassium, will add to the certainty of the results, yet for all practical purposes three or four treatments and a check will be found satisfactory.

Nitrogen-carrying fertilizers, such as nitrate of soda, ammonium sulfate, and animal and vegetable products, are the fertilizers which have been found by other fertilizer tests most generally to produce a response. The first two should be applied in the spring a week or two before the buds begin to swell, and may be most easily handled by sowing in definite amounts around each tree, beginning a few feet away from the trunk and extending several feet beyond the spread of the branches. Mature trees will require from 4 to 8 pounds of nitrate of soda, from 3 to 6 pounds of ammonium sulfate, or from 200 to 300 pounds of manure.

Deficiency of phosphoric acid and potash occurs most frequently in sandy soils, so that on soils of that type attention may be directed towards the requirements of those two materials. They are less likely to produce a response when applied alone than when applied in combination with other materials, especially nitrogenous fertilizers. Eight to 12 pounds of phosphoric acid and 4 to 8 pounds of muriate of potash or 5 to 10 pounds of potassium sulfate may be considered liberal applications.

Four or five trees to a plat is the minimum that can be safely employed, and they should be as nearly alike as possible. The soil must be uniform in fertility, texture, drainage, and general slope. Moreover, each plat of treated trees should be separated from the adjacent plats by a division or guard row of untreated trees so that the effect of

the fertilizers applied to one plat will not affect another. A simple plan would be as follows:

Plat 1. "Complete" fertilizer, consisting of nitrogen, phosphoric acid, and potash. Assuming that the trees are set 40 by 40 feet and are mature trees, the nitrogen may be supplied in 200 pounds of nitrate of soda per acre, or approximately 7½ pounds per tree; the phosphoric acid in 275 pounds of acid phosphate per acre, or 10 pounds per tree; and the potash in 150 pounds of potassium sulfate per acre, or approximately 5 pounds per tree.

Plat 2. Phosphoric acid and potash applied in the same amounts as on Plat 1.

Plat 3. Check, receiving no treatment.

Plat 4. Sulfate of potash applied at the same rate as on Plat 2.

Plat 5. Stable manure if available, 260 pounds to the tree.

Careful records should be kept of the yield and growth of the trees. Before fertilizers are applied a measurement of trunk circumference should be made—a common cloth tape line will serve very well—making the measurement in two places, if possible, say at 1 foot and 3 feet above the ground and averaging the two. At all events, whether one or two measurements are made, they should always be made at the same height above the ground. The yield of the fruit in pounds and the yield of different grades must also be kept. One season's records will hardly suffice as results upon which to base fertilizer practices, but three to five years' careful records should show plainly whether fertilizers are required or not.

APPENDIX

DATA ON THE EXPERIMENT, 1919 TO 1923

TABLE 1.—YEARLY YIELDS OF INDIVIDUAL TREES IN AN ORCHARD FERTILIZER EXPERIMENT.

	LOCATION		YIELD PER TREE IN POUNDS					TOTAL, 1902–1918	GRAND TOTAL
	Row	Tree	1919	1920	1921	1922	923		
	1	1	594	935	36	835	464	4,934	7,798
	2	1	810	733	249	786	249	4,996	7,823
Plat 1	3	1	405	1,359	82	1,529	477	5,613	9,465
Stable manure	4	1	677	785	218	967	637	3,786	7,070
	5	1	823	1,283	435	1,290	496	5,100	9,427
Total	..	..	3,309	5,095	1,020	5,407	2,323	24,429	41,583
Average per tree	..	..	..	..	..	..	..	..	8,316
	7	7	869	1,041	624	368	583	4,733	8,218
Plat 9	8	7	730	429	662	630	746	4,090	7,287
Stable manure	9	7	674	909	445	701	290	4,162	7,181
	10	7	512	1,006	125	833	398	3,865	6,739
	11	7	out	out	out	out	out	omit'd	omit'd
Total (4 trees)	..	..	2,785	3,385	1,856	2,532	2,017	16,850	29,425
Average per tree	..	..	..	..	..	..	..	..	7,353
Treatment average per tree	..	..	..	..	..	..	..	..	7,834
	1	3	500	662	118	596	268	3,440	5,584
	2	3	586	1,070	34	1,048	226	5,081	8,045
Plat 2	3	3	636	1,197	80	1,189	494	5,367	8,963
Phosphoric acid	4	3	657	508	312	758	522	4,386	7,143
	5	3	967	732	714	711	492	4,971	8,587
Total	..	..	3,346	4,169	1,258	4,302	2,002	23,245	38,322
Average per tree	..	..	..	..	..	..	..	..	7,664
	7	9	651	947	512	273	373	4,247	7,003
	8	9	587	507	343	624	590	2,880	5,531
Plat 8	9	9	510	1,129	381	942	749	5,263	8,974
Phosphoric acid	10	9	597	625	367	492	506	3,146	5,733
	11	9	568	449	523	450	502	3,445	5,937
Total	..	..	2,913	3,657	2,126	2,781	2,720	18,981	33,178
Average per tree	..	..	..	..	..	..	..	..	66.35
Treatment average per tree	..	..	..	..	..	..	..	..	7,149

TABLE 1.—(*Continued*).

	Location		Yield per tree in pounds					Total, 1902–1918	Grand total
	Row	Tree	1919	1920	1921	1922	1923		
Plat 6 Phosphoric acid and potash	1	11	651	1,417	90	1,377	707	5,467	9.709
	2	11	491	1,167	68	1,174	919	4,634	8,453
	3	11	763	1,229	71	1,498	537	4,114	8,212
	4	11	1,223	1,403	371	1,548	1,127	6,811	12,483
	5	11	866	866	713	708	381	4,104	7,638
Total	..	..	3,994	6,082	1,313	6,305	3,671	25,130	46,495
Average per tree	..	..	..	..	..	..	..	..	9,299
Plat 10 Phosphoric acid and potash	7	5	1,061	1,041	888	*808	*768	5,796	10,362
	8	5	934	773	665	949	864	4,202	8,387
	9	5	1,287	1,146	985	1,080	1,089	5,331	10,918
	10	5	919	995	559	1,079	838	5,053	9,443
	11	5	704	438	471	126	281	3,256	5,276
Total	..	..	4,905	4,393	3,568	4,042	3,840	23,638	44,386
Average per tree	..	..	..	..	..	..	..	..	8,877
Treatment average per tree	..	..	..	..	..	..	..	..	9,088
Plat 4 Phosphoric acid, potash, and nitrogen	1	7	585	1,472	107	1,456	552	6,539	10,711
	2	7	957	1,106	167	1,230	389	5,665	9,514
	3	7	1,057	1,408	303	1,475	639	5,495	10,377
	4	7	724	769	365	937	629	2,830	6,254
	5	7	1,207	344	1,177	520	547	5,482	9,277
Total	..	..	4,530	5,099	2,119	5,618	2,756	26,011	46,133
Average per tree	..	..	..	..	..	..	..	..	9,226
Plat 12 Phosphoric acid, potash, and nitrogen	7	1	849	719	442	*750	*764	4,368	7,892
	8	1	586	307	521	598	554	2,711	5,277
	9	1	1,066	870	994	802	979	5,493	10,204
	10	1	1,120	954	1,111	894	1,021	6,378	11,478
	11	1	695	483	548	708	504	3,274	6,212
Total	..	..	4,316	3,333	3,616	3,752	3,822	22,224	41,063
Average per tree	..	..	..	..	..	..	..	..	8,212
Treatment average per tree	..	..	..	..	..	..	..	..	8,719

*Computed from average of other trees in plat.

TABLE 1.—(*Concluded*).

	Location		Yield per tree in pounds					Total, 1902–1918	Grand total
	Row	Tree	1919	1920	1921	1922	1923		
	1	5	574	491	297	564	255	2,684	4,865
	2	5	754	961	141	1,024	337	4,726	7,943
Plat 3	3	5	887	1,063	170	1,232	580	4,952	8,884
Check	4	5	1,123	692	715	862	571	5,182	9,145
	5	5	1,224	981	887	1,069	531	6,166	10,858
Total	..	..	4,562	4,188	2,210	4,751	2,274	23,710	41,695
Average per tree	..	..	..	..	..	..	..	..	8,339
	1	9	578	834	128	734	477	3,858	6,609
	2	9	484	928	20	899	444	4,013	6,788
Plat 5	3	9	984	1,291	228	1,513	597	4,723	9,336
Check	4	9	796	582	495	860	705	3,345	6,783
	5	9	887	664	771	660	346	4,002	7,330
Total	..	..	3,729	4,299	1,642	4,666	2,569	19,941	36,846
Average per tree	..	..	..	..	..	..	..	..	7,369
	7	3	590	447	398	*486	*443	2,482	4,846
	8	3	631	570	338	694	503	3,110	5,846
Plat 11	9	3	1,233	710	1,041	840	1,046	5,534	10,404
Check	10	3	1,177	991	1,009	1,041	929	6,039	11,186
	11	3	963	613	738	897	689	4,813	8,713
Total	..	..	4,594	3,331	3,524	3,958	3,610	21,978	40,995
Average per tree	..	..	..	..	..	..	..	..	8,199
Treatment average per tree (15 trees)	..	..	..	..	..	..	..	..	7,969
	7	11	373	933	202	97	725	547†	2,877
Plat 7	8	11	281	250	97	211	105	226†	1,170
Check (omitted	9	11	368	462	287	321	486	422†	2,346
from averages)	10	11	490	201	301	46	331	433†	1,802
	11	11	550	811	198	810	555	984†	3,908
Total	..	..	2,062	2,657	1,085	1,485	2,202	2,612†	12,103

*Computed as 56 per cent of average of other trees in plat on a basis of 1902-18 averages.
†Total for 1917-18 only.

TABLE 2.—INFLUENCE OF TREATMENT ON SIZE OF FRUIT IN ORCHARD FERTILIZER EXPERIMENT.

	LOCAT'N		POUNDS OF FRUIT GRADING 2½ INCHES OR LARGER							
	Row	Tree	1919	1920	1921	1922	1923	Total	Total yield	Percent
Plat 1 stable manure	1	1	429	248	30	718	345	1,170	2,864	61.8
	2	1	337	205	165	708	215	1,630	2,827	57.6
	3	1	358	437	59	1,204	380	2,438	3,852	63.2
	4	1	155	179	90	879	139	1,442	3,284	43.9
	5	1	543	221	277	1,072	471	2,584	4,327	59.7
Total.....	..	..	1,822	1,290	621	4,581	1,550	9,864	17,154	57.5
Plat 9 Stable manure	7	7	322	400	315	200	229	1,466	3,485	42.0
	8	7	80	301	87	577	192	1,237	3,197	38.6
	9	7	309	344	271	445	104	1,473	3,019	48.7
	10	7	209	137	75	374	285	1,080	2,874	37.5
	11	7	out	out	out	out	out	omitted	omitted	omitted
Total (4 trees)...	..	..	920	1,182	748	1,596	810	5,256	12,575	41.7
Plat 2 Phosphoric acid	1	3	324	158	85	505	200	1,272	2,144	59.3
	2	3	431	66	24	851	210	1,582	2,964	53.3
	3	3	487	106	56	780	358	1,787	3,596	50.0
	4	3	116	140	145	628	77	1,106	2,757	40.1
	5	3	143	299	224	621	447	1,734	3,616	47.9
Total.....	..	..	1,501	769	534	3,385	1,292	7,481	15,077	49.6
Plat 8 Phosphoric acid	7	9	419	373	359	161	128	1,440	2,756	52.2
	8	9	278	261	138	512	176	1,365	2,651	51.4
	9	9	339	268	274	854	377	2,112	3,711	56.9
	10	9	151	402	227	419	158	1,357	2,587	52.4
	11	9	223	279	262	389	167	1,320	2,492	52.9
Total.....	..	..	1,410	1,583	1,260	2,335	1,006	7,594	14,197	53.4
Plat 6 Phosphoric acid and potash	1	11	592	630	55	1,077	535	2,889	4,242	68.1
	2	11	439	507	40	1,040	526	2,552	3,819	66.8
	3	11	678	587	36	1,164	469	2,934	4,098	71.5
	4	11	834	655	293	1,382	745	3,909	5,672	68.9
	5	11	239	417	215	626	327	1,824	3,534	51.6
Total.....	..	..	2,782	2,796	639	5,289	2,602	14,108	21,365	66.0
Plat 10 Phosphoric acid and potash	7	5	444	574	503	361	364*	2,246	4,566	49.1
	8	5	190	314	208	804	234	1,750	4,185	41.8
	9	5	551	621	519	942	540	3,173	5,587	56.7
	10	5	296	467	470	839	656	2,728	4,390	63.3
	11	5	78	272	86	85	27	548	2,020	27.1
Total.....	..	..	1,559	2,248	1,786	3,031	1,821	10,445	20,748	50.3

*Computed from average of other trees in plat.

TABLE 2.—(*Concluded*).

	LOCAT'N		POUNDS OF FRUIT GRADING 2½ INCHES OR LARGER							
	Row	Tree	1919	1920	1921	1922	1923	Total	Total yield	Per-cent
	1	7	514	550	70	1,235	494	2,863	4,172	68.6
Plat 4	2	7	567	393	122	1,068	347	2,497	3,849	64.8
Complete	3	7	794	599	252	1,109	486	3,240	4,882	66.3
fertilizer	4	7	242	250	194	770	187	1,643	3,424	47.9
	5	7	177	227	539	438	516	1,897	3,795	49.9
Total.....	..	..	2,294	2,019	1,177	4,620	2,030	12,140	20,122	60.3
	7	1	245	397	39	621*	441*	1,743	3,524	49.4
Plat 12	8	1	147	205	86	509	278	1,225	2,566	47.7
Complete	9	1	360	482	451	708	552	2,553	4,711	54.1
fertilizer	10	1	260	639	423	765	673	2,760	5,100	54.1
	11	1	118	270	76	504	262	1,230	2,938	41.8
Total.....	..	..	1,130	1,993	1,075	3,107	2,206	9,511	18,839	50.4
	1	5	64	53	56	402	75	650	2,181	52.2
	2	5	412	69	84	798	299	1,662	3,217	51.6
Plat 3	3	5	529	200	111	821	418	2,079	3,932	39.4
Check	4	5	255	444	477	761	275	2,212	3,963	64.6
	5	5	320	524	525	929	502	2,800	4,692	59.6
Total.....	..	..	1,580	1,290	1,253	3,711	1,569	9,403	17,985	52.2
	1	9	337	181	80	602	289	1,489	2,751	54.1
Plat 5	2	9	413	216	11	808	392	1,840	2,775	66.3
Check	3	9	757	460	167	1,092	516	2,992	4,613	64.8
	4	9	443	305	366	738	298	2,150	3,438	62.5
	5	9	119	418	269	578	323	1,707	3,328	51.2
Total.....	..	..	2,069	1,580	893	3,818	1,818	10,278	16,905	60.7
	7	3	71	213	103	376†	202†	965	2,364	40.8
Plat 11	8	3	115	138	126	537	106	1,022	2,736	37.3
Check	9	3	230	507	405	715	443	2,300	4,870	47.2
	10	3	224	532	582	750	559	2,647	5,147	51.4
	11	3	79	301	257	686	361	1,684	3,900	43.1
Total.....	..	..	719	1,691	1,473	3,064	1,671	8,618	19,017	45.3
	7	11	295	268	85	35	102	785	2,330	33.6
	8	11	189	135	15	172	78	589	944	62.3
Plat 7	9	11	170	271	132	277	138	988	1,924	51.3
Check	10	11	49	113	71	31	251	515	1,369	37.6
	11	11	309	161	60	603	224	1,357	2,924	46.4
Total.....	..	..	1,012	948	363	1,118	793	4,234	9,491	44.6

*Computed from average of other trees in plat.

†Computed as 56 per cent of average of other trees in plat on a basis of 1911-18 average.