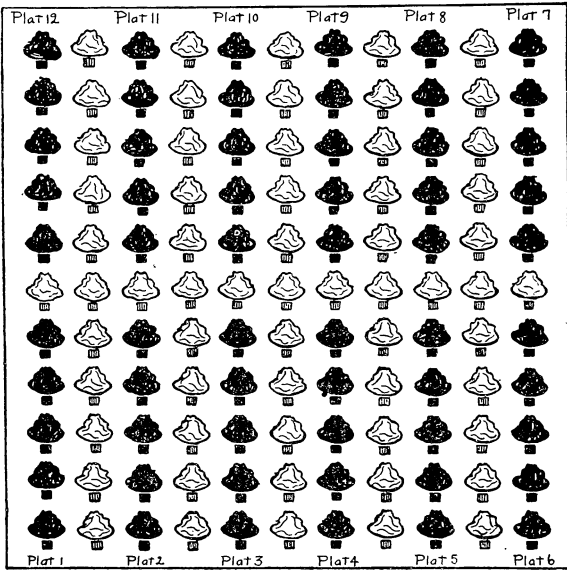


New York Agricultural Experiment Station.

GENEVA, N. Y.



DOES THE APPLE ORCHARD NEED FERTILIZERS?

SUMMARIZED BY

F. H. HALL

FROM BULLETIN BY

U. P. HEDRICK

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* Riverhead, N. Y. † Absent on leave. ‡ Connected with the Chautauqua Grape Work.

POPULAR EDITION*

OF

BULLETIN No. 339

DOES THE APPLE ORCHARD NEED FERTILIZERS?

F. H. HALL

**Fertilizer
needs of
apples not
well studied.**

Fertilizer tests have always been popular with station investigators and the needs of most field and garden crops have been carefully studied by many men in many places. Along one line, however, satisfactory figures are lacking. To ascertain the needs of orchard crops, particularly of the apple, whose trees are of large size and slow growth, requires careful, long continued tests on extensive areas. Less than half a dozen such experiments have been made in America; and few figures are available to the horticulturist, either scientific or practical, who wishes to plan for the fertilization of an apple orchard. Recommendations for manurial applications have necessarily been based on tests made with other crops or on analyses of the fruit. With crops that are similar, estimation of the fertilizer needs of one from what has been proven of another is usually safe; but between the apple and other crops analogy is an unsafe guide. This fruit plant differs too greatly from that of corn or wheat, or even from that of the peach or strawberry, to make the ascertained needs of these crops on any soil a safe measure of the requirements of the apple tree during its growth and fruitage. Neither is the

* This is a brief review of Bulletin No. 339 of this Station entitled "Is it Necessary to Fertilize an Apple Orchard," by U. P. Hedrick. Any one interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin, so long as it is available. Names of those who so request will be placed on the Station mailing list to receive future bulletins, popular or complete, as desired.

analysis of the fruit very helpful; for this merely shows what the tree takes from the soil,—not how good or how poor is the supply of elements in the soil nor with what ease or difficulty the plant can get them.

**Apple
fertilizers
may have
been wasted.**

Yet these bases of estimating the apple's fertilizer needs have been generally used; and recent tests at this Station indicate that the manure and chemicals, often applied very liberally in orchards, have been wasted unless some other crop was grown among the trees. These experiments indicate that on good soils, properly drained and tilled, and with the trees kept in a healthy condition, the apple secures plenty of plant food for its needs and responds but little or not at all to liberal fertilizing. Some reasons why this may well be true are apparent when we consider the development and fruiting of the orchard. The trees grow for several years without setting a crop and when in bearing usually have "off years" in which to lay up a surplus supply of fruit-making materials; they feed deeply and widely; they take up and evaporate immense quantities of water so that even if the soil solution be very dilute because of small quantities of mineral elements present, the total amounts passing into the trees with the water during the long season of growth are ample for all the needs of the crop; the fruit contains a small proportion of solid matters, particularly of those that man often has to furnish for other crops; and the trees return to the soil, in the falling leaves, much of the food utilized. The soil must be of a poor fruit type, indeed, that will not, when properly handled, grow good crops of apples without artificial feeding.

**Indications
from previous
experiments.**

In a twelve-year test on old trees in one of the Station orchards, as recorded in Bulletin 289, the use of liberal quantities of wood ashes, furnishing potash and lime, and of acid phosphate, did not increase the crop to a profitable extent in either number or size of fruits, nor did it improve the quality or color. In another test, incidental to the main comparison of sod mulch

and tillage, the application of fertilizers in the tilled portion of an orchard — where only could the fertilizer effect on the *apples* be studied — was profitless. In the sodded half of the orchard, nitrate of soda was beneficial to the fruit; but probably only because the grass used the nitrate and left in the soil the other food of which it robbed the trees on unfertilized plats.

**New test
proves
fertilizers
profitless.**

Another test in a young orchard has now been carried on fifteen years and confirms the belief that, on the Station soil, fertilizers are wasted in the apple orchard. This orchard has received the same fertilizers on each of the different plats for twelve years and the trees have now borne seven crops of fruit, so that the influence of the different elements of plant food, used alone and in combination, should be evident; yet no constant differences between the plats show in crop yield, quality or color of fruit, increase in trunk diameter, or growth of new wood. During the last season there seemed to be some effect of nitrogen on the plats receiving it, in heavier, greener leaves, slightly greater new growth, and, possibly, increased size of fruit. The last difference may, however, be due to a smaller number of fruits on the nitrogen-fed trees rather than to direct influence of the fertilizer. Practically, it may be said that the money paid for the fertilizers, varying from \$27 to \$186 an acre for the 12 applications, has been buried in the soil. Whether any of it will ever rise to profitable activity now seems doubtful.

**Plan of
test.**

This experiment was planned by the Director of the Station and Prof. S. A. Beach, then Horticulturist, and was supervised by the latter until his removal to Ames, Iowa, in 1906, since which time Prof. U. P. Hedrick, Horticulturist of the Station, has directed the operations in the orchard.

The land selected is a heavy, Dunkirk clay loam, hard to work, very productive of field crops when properly managed; but not of the best type for apple growing. It is well drained, lines of tile

being laid before the trees were set in 1896. The variety of apple selected for the orchard was Rome, budded on Ben Davis stocks. The Ben Davis trees came from a very uniform nursery block and were specially selected for size and shape so that the influence of individuality might be eliminated so far as possible; and the Rome buds all came from one tree of known good quality and productiveness in an older Station orchard.

Rome was selected as an early-maturing, productive, long-keeping red apple, well adapted to show any influence of the fertilizers; and Ben Davis was used as a stock because of its vigor, which Rome lacks, and because it resembles Rome in other characteristics so that any possible influences of stock on cion would be in the same, not opposed, directions.

The trees were set in the spring of 1896 and budded in July of that year. They stand 40 feet apart in rows alternating with other rows of mixed varieties so that ample opportunity for cross pollination is afforded, if necessary or helpful. Five trees at the end of each row comprise a plat, which is separated from the plat at the other end of the row by a tree of another variety. Twelve plats were provided for, four being checks, but one of the latter came near the brow of a small hill on thinner soil and one of its trees was lost by blowing over, so the plat was omitted and only three check plats used. Beginning in 1900, two plats received phosphoric acid only, 50 lbs. to the acre annually in acid phosphate; two phosphoric acid (same amount as above) and potash, 100 lbs. to the acre in the form of muriate; two phosphoric acid, potash (amounts as above) and nitrogen, 50 lbs. per acre, one-fourth in nitrate of soda and three-fourths in dried blood; and two plats received enough stable manure to furnish 50 lbs. of nitrogen to the acre, with undetermined amounts of phosphoric acid and potash. These fertilizers are applied about the trees, over areas slightly greater than the spread of the branches; so that at first, since the trees were small, the acre-rates for the areas actually

fertilized were probably twenty-five times the amounts given above; and even in 1910 only one-eighth of the whole orchard surface was fertilized. Contrary to current belief this excessive fertilization has exerted no harmful influence, even on the stable manure and nitrate plats.

The orchard is given *clean culture* during spring and early summer. In any *sodded* or *cropped* orchard it is impossible to carry on an accurate test of fertilizers for the apple; since the apparent effect of the applications may be due to the effect on the accompanying crop, either by preventing its robbery of food from the apple or by neutralizing some positively injurious effect the grass may have on the trees. A cover crop is sown in late summer or fall. Since legumes would add irregular and unknown amounts of nitrogen and thus disturb the test, they have not been used, but oats, rye, barley, wheat and cow-horn turnips have been sown and turned under to furnish humus.

Owing to the top working and to the pruning necessary to secure the high heads thought desirable by Prof. Beach, the trees did not come into bearing as early as they probably would have done under a different system of training. They developed uniformly and well, however, and bore their first crop of fruit in 1902, in their seventh year from setting. The orchard passed through one severe outbreak of apple aphids in 1903, one of blight in 1906, and lost all its fruit buds and many of the leaf buds for the season of 1908, owing to an experimental application of a miscible oil in the winter of 1907, made through error. The usual treatments for commercial orchards were given, including lime-sulphur for San José scale, bordeaux mixture and arsenicals; and the health and vigor have been well maintained; nor have the trees suffered at any time from severe weather conditions.

Results as shown by fruit. The yields of fruit for the seven crops produced are shown in Table I, and the figures need little comment.

TABLE I.—YIELD OF FRUIT FROM DIFFERENT PLATS IN ORCHARD FERTILIZER EXPERIMENT.

| FERTILIZERS. | 1902. | 1903. | 1905. | 1906. | 1908. | 1909. | 1910. | Average per tree. |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------------|
| | <i>Lbs.</i> | <i>Lbs.</i> | <i>Lbs.</i> | <i>Lbs.</i> | <i>Lbs.</i> | <i>Lbs.</i> | <i>Lbs.</i> | <i>Lbs.</i> |
| Stable manure..... | 27.85 | 71.64 | 597.73 | 215.73 | 1,822.98 | 288.62 | 3,308.60 | 90.47 |
| Phosphoric acid.... | 15.79 | 119.59 | 545.46 | 238.67 | 1,950.09 | 325.00 | 2,936.24 | 87.57 |
| Phosphoric acid and potash..... | 42.03 | 90.65 | 556.39 | 137.17 | 1,930.17 | 622.74 | 3,855.48 | 103.34 |
| Phosphoric acid, potash and nitrogen..... | 53.59 | 67.34 | 644.71 | 203.28 | 1,914.23 | 496.55 | 3,658.09 | 99.10 |
| *None..... | 60.95 | 145.45 | 1,029.50 | 358.10 | 2,589.50 | 752.97 | 4,750.84 | 92.25 |

* Yearly yields are from fifteen trees; ten trees in all other plats.

The fertilizers have, apparently, had no sensible effect upon the yields; although the large crop in 1910 makes the total figures a somewhat unsafe guide, since there was a variation in this crop, due to some cause outside of fertilizers. The yearly rank of the plats is a better index to the effect of the treatments, and in this ranking there are constant shiftings in order; as follows: Stable manure was third in productivity three times out of seven, fourth three times and fifth once; phosphoric acid alone gave the highest yield twice, was second once, fourth once and fifth three times; the potash and phosphoric acid plats were most productive twice, second twice, third once, fourth once, and fifth once; and the complete fertilizer was first but once, second twice, third twice, fourth once and fifth once.

The figures for single trees of the plats merely emphasize these variations in rank; since there are strange fluctuations in the productivity of trees on single plats in different years;— a variation we would hardly expect from trees budded from a single parent upon stocks selected for uniformity. The figures give rather

suggestive evidence that further study is necessary before too much attention is given to "pedigreed" plants.

As previously stated, careful study of the 1910 crop shows that the size of the fruit was slightly increased on the fertilized plats, particularly those receiving nitrogen, and the percentage of culls and seconds slightly reduced; but these differences may be due to a division of the food supply among the smaller number of fruits on these plats rather than to any increased fruit-producing power in the trees induced by the fertilizers.

There were differences in color of the fruit in the orchard in different years, and, as usual on heavy soils, the fruits were inclined to dullness rather than brilliancy in hue. This tendency was not influenced by the fertilizers; that is, no differences in color could be noticed between apples from different plats in the same year, whether the fruit was hanging on the trees, freshly picked and collected in small or large quantities, or held in storage for longer or shorter times. This uniformity of color was the same, whatever the light used for viewing the fruit and no matter by whom judged. The old sayings that "potash paints fruits" and "manure makes green apples" did not hold true in this test. The same uniformity prevailed in texture and flavor of fruit and in keeping quality. Neither were there any physiological disturbances in the fruits on any plat, like the production of dry or corky spots in the flesh, water coring or mealiness.

Considering the apple crops as a whole there was, practically if not absolutely, no return in any way for the money spent for the fertilizers applied.

Effect on trees and leaves. In short-term experiments with apples, results might be shown on the fruit which would be misleading; for the apple tree is not a crop-bearer for a single year only, but for a generation, and any agency that induced heavy fruiting for a season or two might really be detrimental to the orchard owner if it interfered with the development of the trees. Accordingly, the effect of any factor upon the tree is an even better index to the value of the treatment than is the effect on the fruit.

In this test the effect on the trees was gaged by the increase in the diameter of the trunks and by the length and weight of the new growth; while the color of the leaves and their weight were used as supplementary indexes. In none of these characters was any consistent difference shown between unfertilized and fertilized plats; except that during the last season, 1910, the leaves of trees on the plats receiving nitrogen were of a brighter green and were slightly heavier, while the new growth was apparently longer and heavier. Here, as with the increased size of apples, however, the influence may be indirect rather than direct, since the nitrogen-fertilized plats did not give more than an average crop of apples, thus leaving more of the plant food to be turned to other uses. Yet the indications are, that, for the first time, the heavy nitrogen fertilization is showing an effect. This factor will be carefully watched in succeeding years.

Some figures showing the tree, wood and leaf growth are given in Table II. The tree diameters were measured at two places, one foot and four feet above ground; for length and weight of new growth, twenty shoots were cut in each tree, well distributed through the head; and for leaf weight twenty shoots in different parts of the tree were selected and five leaves from each shoot taken, discarding in each case the first four leaves at the base of the shoot.

TABLE II.—INCREASE IN TRUNK DIAMETER, 1905 TO 1910, OF APPLE TREES IN FERTILIZER EXPERIMENT; LENGTH AND WEIGHT OF NEW GROWTH, 1910; AND WEIGHT OF LEAVES, 1910.

| FERTILIZER USED ON PLATS. | Increase in trunk diameter, 1905-1910. | ANNUAL GROWTH. | | WEIGHT OF 100 LEAVES. | |
|--|---|----------------|---------------|--------------------------|---------------|
| | | Length. | Weight. | Green. | Dry. |
| | <i>Inches.</i> | <i>Inches.</i> | <i>Grams.</i> | <i>Grams.</i> | <i>Grams.</i> |
| Stable manure..... | 2.41 | 9.5 | 89.8 | 95.9 | 42.4 |
| Phosphoric acid..... | 2.40 | 8.9 | 81.7 | 88.5 | 40.6 |
| Phosphoric acid and pot- ash..... | 2.49 | 8.5 | 88.6 | 90.9 | 41.2 |
| Phosphoric acid, potash and nitrogen..... | 2.43 | 9.0 | 86.7 | 99.5 | 43.5 |
| None..... | 2.41 | 8.2 | 74.4 | 80.1 | 36.9 |

Conclusion. “The final conclusion must be that the trees in this experiment would be practically as well off in every respect had not an ounce of fertilizer been used about them. If fertilizers have no value for young trees in this orchard, they have no value in innumerable other orchards in New York. Fruit growers are spending money and losing time as we shall try to show in the next paragraphs in ‘carrying coal to Newcastle.’ Again it must be said that the soil in this orchard is about the same as the average of the apple lands in western New York — no better, no worse. If there is any material difference, it is that this experimental plantation has been better tilled and better cared for in most respects than the average orchard. But the trees have not been coddled — the care has not been better than that given in the best commercial orchards. One of the lessons the experiment should teach is that fertilizers are not necessary in some soils if tillage and good care be the rule,— the truth of the old adage ‘tillage is manure.’” *

Why are these results logical? On the Station soils farm and garden crops respond promptly and markedly to the application of fertilizers. Why do apples fail to do so? The orchard soil, by chemical analysis, shows a large stock of the plant food elements supplied in the fertilizers, and these may be more available to the apple than to annual crops. The upper 12 inches of this soil contains 7,300 lbs. of nitrogen to the acre, 3,200 lbs. of phosphoric acid and 31,000 lbs. of potash; enough,— if we accept Dr. Van Slyke’s careful figures for the draft of the apple tree on the soil — to furnish nitrogen for 183 crops of apples, phosphoric acid for 295 years and potash for 713 years, if these materials were all available. Of course they are not all available and cannot be made so; yet the yearly plowing and thorough cultivation given the orchard have loosened, pulverized and aerated the soil, and regulated the moisture; and with the plowing under of the humus-producing cover crops whereby the solvent action of the decaying crops and of the bacteria that live in the soil have been increased, have made

* Quotation from complete bulletin, by U. P. Hedrick.

available some plant food that the plants could not secure at first. This available food the apple tree can utilize better than can field crops for several reasons, as previously noted: It has a far longer time in which to secure its supply because of its slow maturity and its long season of growth each year. Its roots run deeper and spread further; it transpires relatively larger quantities of water and thus from the passage through its tissues of vast quantities of dilute soil solutions it can secure as much food as annual crops would get from richer solutions; it gives a crop that is 85 per ct. water, leaving but a small percentage of solids, particularly mineral solids, to come from the soil; and its leaves return to the earth that produced them, while the coarser portions of field crops, as well as the fruits, are drawn from the fields.

“Is it necessary to fertilize an apple orchard?

**Practical
lessons
from the
experiment.**

This experiment indicates that in the average western New York tilled apple orchard, if well drained, well tilled and properly supplied with organic matter from stable manure or cover crops, commercial fertilizers are little needed. The exceptions will probably be found on sandy and gravelly soils deficient in potash or the phosphates and subject to droughts; or on soils of such shallowness or of such mechanical texture as to limit the root-range of the apple-plant; or in soils so wet or so dry, or so devoid of humus, as to prevent proper biological activities in the soil. These exceptions mean for the most part that a soil in this region possessing the unfavorable qualities named is unfitted for apple culture — at any rate there are still thousands of acres of available fruit land in every part of the apple regions of New York that do not fall in with the exceptions. There are probably many apple orchards in New York that may be benefited by an application of one of the chief elements of fertility. Some may require two of the elements. Few, indeed, should require a complete fertilizer.

“If it be true, as we surmise, from this and other experiments, that good apple lands in New York, of which there are an abund-

ance, need little artificial fertilization if the trees are well cared for, it follows that it is folly to plant apples on lands coming under the exceptions noted; for the cost of production is increased by the cost of fertilizers, and, of more importance, the fertilizers may often be wasted. In other words, it is doubtful if land too poor to grow apples without fertilizers can be profitably converted into permanent good apple land, at least by the use of the mineral manures.

“How may a fruit-grower know whether his trees need fertilizers? It may be assumed at once that if trees are vigorous, bearing well and making a fair amount of new wood each season, they need no additional plant food. If the trees are not in the healthful condition described, the logical thing to do is to look to the drainage, tillage and health of the trees first and the more expensive and less certain fertilization afterward.

“As a last resort, fertilizers ought not to be used to rejuvenate trees unless the owner has obtained positive evidence that his soil is lacking in some of the elements of plant food. To obtain such evidence a fruit-grower should carry on a fertilizer experiment.”*

**Plan for
fertilizer
test.**

In making such a test, select a portion of the orchard as uniform as possible, both in soil and varieties. If available, use at least five trees for each plat and on different plats use fertilizers about as in this Station test: (1) Acid phosphate to give about 50 lbs. of phosphoric acid to the acre, or 13 lbs. of 14 per ct. phosphate to each tree if they stand 40 feet apart; (2) phosphate as above and muriate of potash to give 100 lbs. of potash to the acre, or 8 lbs. of muriate per tree; (3) phosphate and muriate as above and nitrate of soda and dried blood to give 50 lbs. of nitrogen per acre, or 13 lbs. of medium grade dried blood and $3\frac{3}{4}$ lbs. of nitrate of soda per tree. This nitrogen might also be supplied in six tons of good stable manure to the acre, or 400 lbs. per tree; (4) this amount of stable manure should be applied on a fourth plat, and (5) a similar plat should be left unfertilized for a check. This experiment is much less laborious

* Quotation from complete bulletin, by U. P. Hedrick.

and complex than it looks, for the fertilizer combinations are built up one from another and the mixing can be done and quantities weighed out in winter when orchard work is not pressing.

The fertilizers should be applied in the spring as soon as the ground can be worked, spreading them about the trees over an area somewhat greater than covered by the spread of the branches. Apply the manure before plowing, and the fertilizers immediately after it, harrowing them in. The experiment, to be conclusive, should run for several years and the crops should be carefully weighed or measured, giving due consideration to culls and windfalls.