# VEGETATIVE GROWTH OF ELBERTA AND REDHAVEN PEACH TREES AS INFLUENCED BY SOIL MOISTURE VARIATIONS

by

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# INTRODUCTION

Water is a major factor in the physiological processes of the plant. Plant growth is primarily the result of cell division and cell enlargement. Investigations conducted by D. J. Watson, of the Rothamsted Experiment Station in England on sugar beets indicate that soil moisture deficits affect growth mainly by inhibiting cell enlargement, rather than by affecting cell division, as stated by Wadleigh (25).

Contrary to popular opinion the roots of trees do not usually penetrate for very great distances into the soil according to Meyer and Anderson (18). Most of the root system as a rule, of the vast majority of trees will be found in the upper few feet of the soil. A few roots penetrate to greater depths, soil conditions permitting, but growth of tree roots to a depth of more than 10 feet beneath the soil surface is uncommon. Trees growing in deep, well-drained soils, especially if sandy or gravelly, may sometimes be exceptions to this statement.

Soil moisture is frequently one of the major limiting factors in fruit production in Kansas. The amount of rainfall is variable and distribution is sometimes uneven. Frequently only the top few inches of soil is wetted and the subsoil remains dry while at other times the soil is wetted to a depth of several feet.

This experiment was planned to investigate the effect on vegetative growth of peach trees when subjected to various levels of soil moisture for a sustained period of time. It was also planned to investigate the effect a limited soil moisture level followed by an optimum level would have on the vegetative growth.

Review of the literature has not disclosed any reference to studies of this nature having been conducted with peach trees.

Irrigation and orchard management practices are both costly and laborious. The cost of labor and equipment is high. The margin of profit is narrow. If these costs could be reduced through more efficient irrigation practices the results would be beneficial from the standpoint of the fruit grower.

## REVIEW OF LITERATURE

The literature pertaining to soil moisture relations and plant function is voluminous.

Veihmeyer and Hendrickson (24) stated the appearance of trees growing in soils having high available moisture range to be indistinguishable from those growing in soils where the available moisture was depleted before the supply was replenished.

It has been stated by Wadleigh and Richards (26) that with other factors being favorable, plants can grow and absorb moisture at soil moisture levels ranging from saturation down to some minimum moisture content associated with the wilting of plants. This minimum level depends on the texture of the soil. The evidence indicates that some species of plants, e. g., the tree fruits, show no response in productiveness regardless of the level of soil moisture maintained above the wilting percentage.

Kenworthy (13) using one-year-old Winesap apple whips found the shoot growth to be significantly reduced when the trees were allowed to deplete the soil moisture to 80 percent of the available supply prior to watering. He also reported a significant reduction in shoot diameter, trunk diameter increase, and dry weight. He stated also that the moisture content of the entire tree is significantly reduced by permitting the tree to wilt prior to watering.

In field studies with Muir peach in California, Hendrickson and Veihmeyer (10) reported that the maintenance of soil moisture continuously above the wilting percentage resulted in the production of the largest trees and a deficiency of readily available moisture for comparatively brief periods resulted in a decrease in growth but not a significant decrease in yield.

In irrigation studies with apricots, Hendrickson and Veihmeyer (9) found trunk growth to be influenced by the number and length of periods the trees were without readily available moisture and the size of the crop produced.

Gardner, et al. (6) reported that frequent applications of irrigation water applied to peaches on a gravel loam at intervals of seven to eight days produced a more continuous and greater total twig growth than the same total amount of water applied with larger applications at intervals of every 10 to 12 days.

Barss, as stated by Gardner, et al. (6), reporting upon the results of some pot irrigation experiments with pears states:

> The most noticeable variation in response to the application of different amounts of water, was found in the development of the new wood. All the lots started vegetative growth at about the same time, but the terminal bud formation took place early in the poorly watered trees and much later on the trees of the other lots. Furthermore there were great differences in the rate of wood growth in these different lots while they were actually growing.

Lewis, et al. (15) reported the rate of growth of pear fruits growing in the heavy soils of Oregon to be markedly affected by comparatively small variations in the moisture content of the soil of the root zone, even when the moisture content was well above the wilting point.

Aldrich and Work (1) stated that in a heavy soil type apparently a moisture supply representing approximately 50 percent of the maximum available moisture, or over, is essential for maximum growth of fruit, shoots, and trunk.

Allmendinger, et al. (2), studying the carbon dioxide uptake of apple leaves at different soil moisture levels, reported that a reduction in growth occurred, measured by terminal elongation, when more than three-fifths of the available soil moisture had been removed.

A significant difference between the length and diameter of the terminal growth of Jonathan and Golden Delicious apple trees grown in pots under conditions each of high and low soil moisture levels was revealed by Simons (21). He also found a significant difference between trees grown at different soil moisture levels in size of leaf and width and length of the palisade, epidermal, and xylem cells.

The period of rapid development of peach fruits was initiated in both irrigated and non-irrigated plots at the same time although the moisture content of the non-irrigated plots was below the wilting coefficient according to Cullinan and Weinberger (5). The average daily volume increase in the peach fruits on the irrigated plots was 2.61 centimeters while on the non-irrigated plots it was

1.65 centimeters.

Hendrickson and Veihmeyer (11) reported the weights of various sizes of pears, peaches, and prunes from trees kept supplied with readily available soil moisture were reflected by the total number of fruits on the trees and not by the different soil moisture conditions. They reported no evidence to indicate any benefit, as far as final size is concerned, to be obtained by keeping the soil moisture high.

Conrad and Veihmeyer (4) found that the drying of the soil below the surface layer is the result of root activity, and that dry soils must, then, necessarily mean the presence of roots. They stated that if the soil is wet to the full depth to which roots of the particular plant in question would normally go at the beginning of the growing season, then subsequent applications of water during the summer can have little influence on the extent of the distribution of the roots.

The observations by Rogers (19) of roots growing in a sandy soil in England showed that soil moisture appears to act as limiting factor to root growth well before the wilting range is reached. He also reported the growth of the roots was slowed considerably when soil temperatures were above 69 degrees Fahrenheit.

Magness, et al. (16) in soil moisture studies in eastern United States stated the growth rate of fruit trees in moderately textured soils is generally not measurably reduced because of soil moisture shortage until at least the driest part of the root zone approaches the wilting percentage.

Some other factors that have been used in studies of soil moisture relations are the effect of soil moisture on stomatal effect, rate of photosynthesis and transpiration.

Hendrickson (8) found the stomata of peach, prune, and apricot trees growing under conditions of little or no available soil moisture showed a smaller maximum stomatal opening than trees growing in soil containing a supply of available moisture.

It has been reported by Magness, et al. (16) the first measurable effect of reduced moisture supply in the functioning of apple trees is an earlier closing of the stomata and this occurs prior to a reduction in the growth rate of the fruit.

They found that leaf function is reduced and the total carbohydrate materials is less in trees grown under conditions of insufficient moisture.

The reduction of soil moisture under relatively constant atmospheric conditions was reflected in tree behavior by shortening of the period during which the stomata were open and functioning in food elaboration according to Jones (12). He determined that the minimum leaf area which favors the production of quality fruit varied markedly under different soil moisture treatments.

Weinberger (27) reported that during humid periods with an available supply of soil moisture stomata were active for the longest periods and fruit growth was most active while during hot, dry periods the stomata functioned for only a short time daily, and fruit growth was inhibited.

He believed that stomatal movement furnishes a criterion of the moisture relations of the peach tree and indicates whether a sufficient moisture supply is available for maximum growth.

With the gradual drying of the soil an appreciable reduction in the rate of photosynthesis and transpiration was found by Heinicke and Childers (7).

Schneider and Childers (20) determined that before wilting is evident a marked reduction is apparent in photosynthesis and transpiration, and there is an increase in respiration. In one case they found a 55 percent reduction in photosynthesis, a 65 percent reduction in transpiration, and a 62 percent increase in respiration.

Kramer (14) wrote that the apparent equal availability of water over the entire range is explained on the basis that there is but a small change in the forces with which water is held by the soil over the range from field capacity to the permanent wilting percentage. The permanent wilting percentage was found to occur at the moisture content where these forces begin to increase very rapidly, and a small decrease in soil moisture is accompanied by a very rapid increase in the force required to move water from the soil to the roots.

## METHODS AND MATERIALS

### 1956 Planting

The peach varieties Elberta and Redhaven, purchased from a commercial nursery, were planted May 22 and 23 in boxes made of used cypress lumber.

The boxes had dimensions of 19 inches by 19 inches by 16 inches in depth. Approximately 160 pounds of field soil was placed in each box. These boxes were placed in a trench with about four inches of the top of the box remaining above ground level. Galvanized roofing tin was used to line all side joints with the bottoms left unlined.

The soil used was a sandy loam with a moisture equivalent of 19.3 percent and a wilting coefficient of 8.0 percent. The moisture equivalent was obtained by the centrifuge method (22). The wilting coefficient was obtained by the pressure membrane apparatus method (22).

At the time of planting all trees were pruned to a central trunk and topped to a uniform height of 30 inches. Soil moisture in all boxes was brought to the moisture equivalent. Trunk measurements were taken just above the bud union. The trees planted were selected for uniformity of size in tops and roots within the variety.

One plaster of paris moisture block (3) was placed in each box. This moisture block was placed 10 inches below the soil surface in the center of the box. Moisture readings were taken with a moisture detector.

After the trees were planted the boxes were covered with Waltex, a moisture proof material, to prevent moisture in the form of rain from entering and to minimize evaporation from the boxes.

A total of 27 trees of each variety was planted. Trees of each variety were divided into three treatment groups of nine trees each. Treatments were designated as low moisture, medium moisture, and high moisture treatments.

The moisture detector scale was divided into three moisture ranges. The readings from 0 to 30 were designated as dry, 30 to 80 wet, and 80 to 100 very wet.

Trees receiving the low moisture treatment had one gallon of water applied when the readings on the moisture detector were in the range of 0 to 5. The medium moisture applications consisted of one and one-half gallons of water applied when readings on the moisture detector were in the 25 to 30 range. One gallon of water was applied to trees assigned to the high moisture treatment when moisture detector readings reached a reading of 48. Calibration tests between the moisture blocks and moisture content of the soil showed a reading of 48 on the moisture detector was equivalent to 50 percent of the available soil moisture. Soil moisture calculations showed that it would take two gallons of water to bring the soil mass in each box from wilting coefficient to the moisture equivalent.

This procedure of watering was followed throughout the growing season. After trees were dormant in the fall and before low temperatures of winter all treatments were watered to bring the soil mass to the moisture equivalent.

Due to the death of some Elberta trees in the low and high moisture treatments shortly after planting, an adjustment in the number of trees per treatment was made at the end of the 1956 growing season. Six trees each of the Elberta and Redhaven varieties selected at random from the medium moisture treatment and three trees of the Redhaven variety from each the low and high moisture treatment were removed from the boxes and subjected to certain quantitative measurements in the spring of 1957. Trunk diameters and dry weights of the trunks, shoots, and roots were obtained. The remaining three trees each of the Elberta and Redhaven varieties in the medium moisture treatment were discarded.

The six trees of each variety of the remaining two treatments were grown again in 1957. The boxes with the trees intact were removed from the trenches and placed above ground. Trunk diameters were measured before growth was initiated. All trees were grown at the high soil moisture level in 1957. This was done to determine the effect this high soil moisture level had on length and diameter of 1957 terminal growth and total growth of the trunks, shoots, and roots of trees in the low moisture treatment group when compared to trees in the high moisture treatment group.

## 1957 Planting

Planting procedure and materials used for the 1957 planting were the same as those used for the 1956 planting except all box sides were lined with clear polyethylene plastic sheets and the boxes were not placed in trenches. The peach varieties Elberta and Redhaven were also used in this planting.

Eighteen trees of each variety were planted June 14, 1957. The trees were divided into three treatment groups of six trees per variety per treatment. These treatment groups are designated as group I, group II, and group III.

Trees of group I were permitted to show visible wilting of the leaves before receiving water. One gallon of water per tree was applied in the evening or early morning after visible wilting

EXPLANATION OF PLATE I

General view of the trees of the 1957 planting growing in the boxes. Note Waltex box covers and lead wires from the moisture detecting blocks. Redhaven trees of group II in the foreground.

PLATE I

## EXPLANATION OF PLATE II

A. Elberta tree of group I grown at the low soil moisture level in the 1957 planting. Waltex box cover has been removed in preparation for removal of the tree.

B. Elberta tree of group III grown at the high soil moisture level in the 1957 planting. Note polyethylene plastic box lining.

PLATE II

A B

EXPLANATION OF PLATE III

A. Redhaven tree of group I grown at the low soil moisture level in the 1957 planting. Waltex box cover has been removed in preparation for removal of the tree.

B. Redhaven tree of group III grown at the high soil moisture level in the 1957 planting. Note polyethylene plastic box lining.

PLATE III

A B

was observed.

Trees of group II were also permitted to show visible wilting before receiving water. Two gallons of water per tree were applied either in the evening or early morning as in group I. This was the amount of water calculated to bring the soil to the moisture equivalent.

Trees of group III were allowed to deplete 50 percent of the available soil moisture before rewatering. When readings on the moisture detector showed that 50 percent of the available moisture had been utilized one gallon of water was applied to each tree.

## RESULTS

### 1956 Planting

The procedure of removing the trees from the boxes and of obtaining the pertinent data was the same for all treatment groups. The boxes were removed from around the soil mass and the soil washed from the roots by means of a pressure nozzle attached to a garden hose. Trunk diameters were measured before removing trees from the boxes. The trees were divided into their component parts of trunks, shoots, and roots. The parts of each tree were placed separately in paper bags and immediately put in a drying oven at a temperature of 105 degrees Centigrade. All tree parts were removed and dry weights obtained at the end of the drying period of 72 hours.

Dry weights for the Redhaven trees that were removed at the end of the 1956 growing season are found in Table 1. As stated previously due to the death of some of the Elberta trees no analysis

Table 1. Dry weight in grams of trunks, shoots, and roots of Redhaven peach trees, 1956 planting, grown only in 1956.

| Tree No. | Trunks | Shoots | Roots |
|---|---|---|---|
| | | High Moisture Treatment | |
| 19 | 127.5 | 105.0 | 120.0 |
| 20 | 119.5 | 110.5 | 134.5 |
| 21 | 131.0 | 112.5 | 138.5 |
| | | Medium Moisture Treatment | |
| 7 | 105.0 | 75.5 | 148.5 |
| 8 | 92.5 | 56.0 | 96.0 |
| 9 | 103.5 | 70.5 | 92.0 |
| 10 | 116.5 | 81.5 | 119.0 |
| 11 | 107.5 | 50.0 | 106.5 |
| 12 | 107.0 | 79.5 | 107.5 |
| | | Low Moisture Treatment | |
| 22 | 66.5 | 25.5 | 59.3 |
| 23 | 70.5 | 31.0 | 64.0 |
| 24 | 84.5 | 38.5 | 79.5 |

was made on this variety at this time. Trunk diameter analysis of the medium moisture group of the Elberta variety will be discussed later.

It was found when the data in Table 1 were analyzed there were significant differences in mean dry weight among the component parts of all trees receiving the different treatments with the exception of the roots (Table 2). The average dry weight of roots of the trees receiving the low moisture treatment was significantly smaller than those of the other two treatment groups. The dry weight differences between the latter two groups were not significant. The soil moisture content increase from the low to the

Table 2. The ordered array of treatment means of the dry weight in grams of the trunks, shoots, and roots of Redhaven peach trees 1956 planting, grown only in 1956.

| Treatment | Trunks | Shoots | Roots |
|---|---|---|---|
| | Mean | | |
| High moisture | 126.00 | 109.33 | 131.00 |
| | * | * | ns |
| Medium moisture | 105.00 | 68.83 | 111.58 |
| | * | * | * |
| Low moisture | 73.83 | 31.67 | 67.60 |
| L.S.D. at 5% | 12.49 | 16.49 | 26.66 |

medium level resulted in a significant increase in the dry weights of trunks and roots. The soil moisture increase from the medium to the high level resulted in a significant increase in dry weight of the trunks but not of the roots. The dry weight of the shoots increased in a linear manner from the low to medium to high moisture treatment groups, although the amount of water added to each treatment group was not linear. The dry weight differences of the shoots were significant among all treatment groups.

As stated previously, six trees of each variety of both low and high moisture treatment groups of 1956 were grown during 1957 at a high moisture level. These 24 trees were removed from the boxes in November 1957; trunk diameters, dry weight of trunks, shoots, and roots, and the length and diameter of 1957 terminal growth were obtained. Procedure of removal of the trees was the same as in 1956. Trunk diameter measurements (Table 3) and shoot counts were made before trees were removed from the boxes. After removal the trees were divided into component parts of trunks, shoots, and roots with individual trees within the variety and

Table 3. Trunk diameter in centimeters taken at base of Elberta and Redhaven peach trees, 1956 planting.

| | Elberta | | | Redhaven | | |
|---|---|---|---|---|---|---|
| Tree No. | Base 6/14 1956 | Base 1/7 1957 | Base 11/14 1957 | Base 6/14 1956 | Base 1/7 1957 | Base 11/14 1957 |
| | | | **High Moisture Treatment** | | | |
| 1 | 0.8 | 1.8 | 2.2 | 1.1 | 2.2 | 2.6 |
| 2 | 0.9 | 1.9 | 2.4 | 1.2 | 2.1 | 2.9 |
| 3 | 0.8 | 2.0 | 2.4 | 1.2 | 2.3 | 2.5 |
| 4 | 1.0 | 1.9 | 2.3 | 1.3 | 2.1 | 2.6 |
| 5 | 0.8 | 1.6 | 2.2 | 1.0 | 1.9 | 2.4 |
| 6 | 0.9 | 1.5 | 2.3 | 1.2 | 2.4 | 2.9 |
| Average | 0.87 | 1.78 | 2.30 | 1.17 | 2.17 | 2.65 |
| | | | **Medium Moisture Treatment*** | | | |
| 7 | 0.8 | 1.6 | | 1.1 | 1.9 | |
| 8 | 0.8 | 1.7 | | 1.1 | 1.6 | |
| 9 | 0.9 | 1.2 | | 1.3 | 1.9 | |
| 10 | 0.8 | 1.6 | | 0.9 | 1.9 | |
| 11 | 0.9 | 1.5 | | 1.0 | 1.8 | |
| 12 | 0.7 | 1.6 | | 1.0 | 2.0 | |
| Average | 0.82 | 1.53 | | 1.07 | 1.85 | |
| | | | **Low Moisture Treatment** | | | |
| 13 | 0.7 | 1.8 | 2.2 | 1.2 | 1.8 | 2.0 |
| 14 | 0.9 | 1.7 | 2.1 | 1.1 | 1.6 | 2.1 |
| 15 | 0.8 | 1.7 | 2.1 | 1.1 | 1.5 | 2.0 |
| 16 | 0.8 | 1.7 | 2.0 | 1.1 | 1.4 | 2.0 |
| 17 | 0.9 | 1.7 | 2.3 | 1.1 | 1.6 | 2.2 |
| 18 | 0.9 | 1.7 | 2.2 | 1.2 | 1.6 | 2.7 |
| Average | 0.83 | 1.72 | 2.15 | 1.13 | 1.58 | 2.33 |

* This treatment grown only in 1956.

treatment kept separate. The shoots were further separated into 1956 growth and 1957 terminal growth. The length and diameter of the 1957 terminal growth was recorded (Table 4). The dry weights

Table 4. Length and diameter in centimeters of 1957 terminal shoot growth of Elberta and Redhaven peach trees, 1956 planting.

| Tree No. | Elberta | | | | | Redhaven | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of shoots | Total length | Average length | Total diameter | Average diameter | No. of shoots | Total length | Average length | Total diameter | Average diameter |
| | | | | | High Moisture Treatment | | | | | |
| 1 | 33 | 292.0 | 8.8 | 10.1 | 0.30 | 36 | 419.0 | 11.6 | 10.5 | 0.29 |
| 2 | 31 | 218.5 | 7.0 | 9.4 | .33 | 39 | 462.5 | 11.8 | 12.9 | .33 |
| 3 | 32 | 225.0 | 7.0 | 9.2 | .29 | 45 | 350.5 | 7.8 | 12.7 | .28 |
| 4 | 26 | 296.5 | 11.4 | 7.9 | .30 | 35 | 283.0 | 8.1 | 11.6 | .33 |
| 5 | 24 | 410.5 | 17.1 | 7.8 | .32 | 28 | 259.0 | 9.2 | 7.5 | .26 |
| 6 | 24 | 363.0 | 15.0 | 8.3 | .34 | 44 | 356.0 | 8.1 | 13.2 | .30 |
| | Av. 28 | | | | | Av. 38 | | | | |
| | | | | | Low Moisture Treatment | | | | | |
| 13 | 17 | 270.5 | 15.9 | 6.1 | 0.36 | 24 | 440.5 | 18.3 | 7.6 | 0.31 |
| 14 | 32 | 317.0 | 9.9 | 9.9 | .29 | 26 | 604.0 | 23.2 | 8.6 | .33 |
| 15 | 25 | 280.5 | 11.2 | 7.9 | .31 | 20 | 543.0 | 27.1 | 7.0 | .35 |
| 16 | 23 | 249.0 | 10.8 | 7.1 | .31 | 21 | 579.0 | 27.6 | 7.8 | .37 |
| 17 | 20 | 394.0 | 19.7 | 6.7 | .33 | 30 | 657.0 | 21.9 | 9.9 | .33 |
| 18 | 29 | 530.5 | 18.3 | 10.4 | .37 | 24 | 420.0 | 17.5 | 8.0 | .33 |
| | Av. 24 | | | | | Av. 24 | | | | |
| /t/ | | -0.739 | -1.33 | 0.937 | -1.327 | | -3.745 | -6.968 | 3.348 | -2.828 |
| y# | 1.36 | | | | | 2.72 | | | | |
| P | ) .10 | ) .40 | ) .20 | ) .30 | ) .20 | ( .01 | ( .01 | ( .001 | ( .01 | ( .02 |
| Sig. | ns | ns | ns | ns | ns | ** | ** | *** | ** | * |

# Whitney-Mann-Wilcoxon ranking test used with alternative hypothesis that high moisture increases number of shoots.

of the combined shoot growth of 1956 and 1957 were then obtained (Table 5).

Table 5. Comparison of dry weight in grams of trunks, shoots, and roots of Elberta and Redhaven peach trees, 1956 planting.

| Tree No. | Elberta | | | Redhaven | | |
|---|---|---|---|---|---|---|
| | Trunks | Shoots | Roots | Trunks | Shoots | Roots |
| | | | High Moisture Treatment | | | |
| 1 | 138.0 | 134.0 | 362.5 | 186.0 | 186.5 | 275.0 |
| 2 | 153.0 | 156.0 | 287.0 | 279.0 | 281.0 | 366.5 |
| 3 | 112.0 | 134.0 | 331.0 | 205.0 | 228.0 | 322.0 |
| 4 | 123.0 | 219.0 | 359.5 | 157.0 | 205.0 | 376.0 |
| 5 | 92.0 | 153.0 | 278.5 | 142.0 | 135.0 | 207.5 |
| 6 | 116.0 | 160.0 | 281.0 | 284.0 | 207.0 | 418.0 |
| | | | Low Moisture Treatment | | | |
| 13 | 162.0 | 133.0 | 312.0 | 108.0 | 104.0 | 243.0 |
| 14 | 126.0 | 120.0 | 219.0 | 127.0 | 123.0 | 231.0 |
| 15 | 140.0 | 128.5 | 324.0 | 119.0 | 133.5 | 202.0 |
| 16 | 115.0 | 91.0 | 255.0 | 113.0 | 108.0 | 221.0 |
| 17 | 136.0 | 217.0 | 389.0 | 121.0 | 178.0 | 315.5 |
| 18 | 118.0 | 117.0 | 246.5 | 200.0 | 164.0 | 384.0 |
| /t/ | 0.939 | 1.147 | 0.850 | 2.732 | 3.113 | 1.454 |
| P | ) .30 | ) .20 | ) .40 | ( .05 | ( .02 | ) .10 |
| Sig. | ns | ns | ns | * | * | ns |

A Whitney-Mann-Wilcoxon ranking test (17),(28) was made on shoot number to see if increased moisture increased shoot number per tree. It is noted in Table 4 there is no significant difference in number of shoots in the Elberta variety among the treatments. The trees of the Elberta variety held at a high soil moisture level had no significantly greater number of shoots than those grown at the low moisture levels. The Redhaven variety responded in a different manner. It was found in this test that the trees in the high moisture treatment showed a definite increase in shoot numbers as compared to the trees of the low moisture treatment group.

The 1957 terminal growth data and analysis results are shown in Table 4. It was found from the analysis, the Elberta trees showed no significant differences either in length or diameter of 1957 terminal growth among the trees grown at the different soil moisture levels in 1956. The Redhaven trees that received the low moisture treatment in 1956 and high moisture treatment in 1957 showed a significant increase in total length, average length, and average diameter when compared with the trees that were in high moisture treatment groups in both 1956 and 1957. However, the total diameter of the terminal growth was significantly larger in the trees grown at the high moisture level in both 1956 and 1957.

No significant differences in total dry weight of the trunks, shoots, or roots were found in the Elberta trees in the treatment groups of the 1956 planting (Table 5).

The dry weights of the trunks and shoots of the Redhaven trees in the high moisture treatment groups of 1956 and 1957 were significantly higher than the trees in the low moisture group in 1956 and grown at the increased moisture level in 1957. There was no significant difference found in the dry weight of roots of the Redhaven trees (Table 5).

There was no significant difference in the diameter of trunks among the Elberta trees in the low, medium, or high moisture treatment groups in 1956 (Table 6). The low and high moisture treatment groups of 1956, both of which were grown in 1957 at a high moisture

Table 6. The ordered array of treatment means of the trunk diameter in centimeters taken at base of Elberta and Redhaven peach trees, 1956 planting.

| 6/14/56 - 1/7/57 | | | | 6/14/56 - 11/14/57 | | | |
|---|---|---|---|---|---|---|---|
| Elberta | | Redhaven | | Elberta | | Redhaven | |
| Treatment | Mean | Treatment | Mean | Treatment | Mean | Treatment | Mean |
| High | 0.90 | High | 1.00 | High | 1.40 | High | 1.50 |
| | | | ** | | | | * |
| Low | 0.90 | Medium# | 0.80 | Low | 1.30 | Low | 1.00 |
| | | | *** | | | | |
| Medium# | 0.70 | Low | 0.40 | | | | |
| L.S.D. at 5% | ns | | 0.20 | | ns | | 0.28 |

# Medium moisture treatment grown only in 1956.

level, also showed no significant differences in trunk growth for the period June 14, 1956 to November 14, 1957.

The trunk diameters of the Redhaven trees differed significantly among all the treatment groups (Table 6). The increase in trunk diameter was highly significant between the low and medium treatment groups for the period from June 14, 1956 to January 7, 1957 and very significant between the medium moisture and high moisture groups for the same period. The trunk diameters of the Redhaven trees of the 1956 low and high moisture treatment groups were significantly different at the end of the experiment. Both groups of trees were grown at a high moisture level in 1957.

## 1957 Planting

The trees were planted June 14, 1957 and removed from the boxes November 15, 1957 by the same procedure as used with the 1956 planting. Trunk diameters were taken before removing the trees from the containers. The trees were divided into their component parts and appropriate measurements and weights were recorded.

The total dry weights of the trunks, shoots, and roots of both the Elberta and Redhaven trees are presented in Table 7.

Table 7. Dry weight in grams of the trunks, shoots, and roots of Elberta and Redhaven peach trees, 1957 planting.

| | Elberta | | | Redhaven | | |
|---|---|---|---|---|---|---|
| Tree No. | Trunks | Shoots | Roots | Trunks | Shoots | Roots |
| | | | Group I | | | |
| 1 | 32.5 | 22.0 | 56.0 | 40.5 | 22.5 | 90.5 |
| 2 | 31.0 | 16.0 | 58.0 | 33.0 | 19.7 | 69.0 |
| 3 | 33.0 | 20.5 | 56.0 | 31.0 | 19.5 | 63.0 |
| 4 | 31.5 | 17.0 | 76.0 | 33.0 | 21.5 | 66.5 |
| 5 | 36.0 | 16.5 | 45.0 | 37.5 | 14.0 | 90.0 |
| | | | Group II | | | |
| 6 | 53.5 | 30.0 | 90.0 | 35.0 | 27.0 | 86.0 |
| 7 | 42.0 | 30.5 | 75.0 | 34.0 | 22.0 | 84.0 |
| 8 | 35.5 | 20.0 | 56.0 | 43.5 | 35.0 | 90.0 |
| 9 | 48.5 | 32.0 | 84.0 | 33.0 | 22.0 | 63.0 |
| 10 | 37.0 | 22.5 | 63.0 | 38.0 | 46.5 | 90.0 |
| | | | Group III | | | |
| 11 | 44.0 | 32.0 | 55.0 | 38.0 | 39.0 | 120.5 |
| 12 | 45.5 | 27.5 | 64.5 | 46.0 | 44.5 | 85.0 |
| 13 | 70.0 | 40.5 | 92.0 | 42.5 | 31.0 | 65.0 |
| 14 | 47.5 | 27.0 | 70.0 | 51.5 | 36.0 | 142.0 |
| 15 | 59.0 | 33.0 | 87.0 | 40.0 | 34.0 | 132.0 |

The average dry weight of the trunks of the Elberta trees was significantly higher in groups II and III than in group I, but no significant difference was found between the dry weights of trunks of groups II and III (Table 8). The average dry weight of trunks

Table 8. The ordered array of treatment means of the dry weight in grams of the trunks, shoots, and roots of Elberta and Redhaven peach trees, 1957 planting.

| Group | Elberta | | | Redhaven | | |
|---|---|---|---|---|---|---|
| | Trunks | Shoots | Roots | Trunks | Shoots | Roots |
| | Mean | | | Mean | | |
| III | 53.20 | 32.00 | 73.70 | 43.60 | 36.90 | 108.90 |
| | | ns | | * | | |
| II | 43.30 | 27.00 | 73.60 | 36.70 | 30.50 | 82.60 |
| | * | * | | ns | * | |
| I | 32.80 | 18.40 | 58.20 | 35.00 | 19.44 | 75.80 |
| L.S.D. at 5% | 10.83 | 6.45 | ns | 6.24 | 9.60 | ns |

of group III of the Redhaven trees was significantly greater than those of groups I and II. The difference in dry weight between groups I and II was not significant.

Trunk diameter measurements were made on all trees at the base of the trunk, 6 inches above the base and 12 inches above the base (Table 9). There were no significant differences in trunk size at the base of the Elberta trees among the treatment groups (Table 10). The average trunk diameters of the Elberta trees 6 inches above the trunk base were significantly greater in groups II and III when compared to group I although no significant difference was found between groups II and III. Twelve inches above the base of the Elberta trees, the trunks of the group III trees were significantly larger than those of group I. The differences in average trunk diameter were nearly significant between groups I and II and between groups II and III.

The average trunk diameter at the base of the Redhaven trees was significantly greater in groups II and III than in group I.

Table 9. Trunk diameters in centimeters measured at trunk base, 6 inches above base, and 12 inches above base of Elberta and Redhaven peach trees, 1957 planting.

| | Elberta | | | | Redhaven | | | |
|---|---|---|---|---|---|---|---|---|
| | | November 15 | | | | November 15 | | |
| Tree No. | June 14 base | Base | 6-inch height | 12-inch height | June 14 base | Base | 6-inch height | 12-inch height |
| | | | | Group I | | | | |
| 1 | 0.85 | 1.10 | 0.90 | 0.70 | 1.00 | 1.20 | 1.00 | 0.80 |
| 2 | 0.80 | 1.10 | 0.90 | 0.80 | 0.80 | 1.00 | 0.90 | 0.60 |
| 3 | 0.60 | 1.10 | 0.90 | 0.60 | 0.85 | 1.10 | 0.80 | 0.60 |
| 4 | 0.90 | 1.20 | 1.00 | 0.60 | 0.90 | 1.10 | 1.00 | 0.70 |
| 5 | 0.70 | 1.10 | 0.90 | 0.70 | 1.00 | 1.20 | 0.90 | 0.80 |
| | | | | Group II | | | | |
| 6 | 0.85 | 1.40 | 1.10 | 0.80 | 0.75 | 1.10 | 0.80 | 0.60 |
| 7 | 0.65 | 1.30 | 1.10 | 0.70 | 0.60 | 1.20 | 0.80 | 0.70 |
| 8 | 0.80 | 1.20 | 1.00 | 0.80 | 0.95 | 1.20 | 0.90 | 0.80 |
| 9 | 0.90 | 1.40 | 1.10 | 0.90 | 0.75 | 1.10 | 0.90 | 0.70 |
| 10 | 0.85 | 1.20 | 1.00 | 0.80 | 0.85 | 1.30 | 0.90 | 0.80 |
| | | | | Group III | | | | |
| 11 | 0.90 | 1.40 | 1.00 | 0.80 | 0.65 | 1.30 | 1.00 | 0.80 |
| 12 | 0.85 | 1.20 | 1.00 | 0.90 | 0.90 | 1.30 | 1.10 | 0.90 |
| 13 | 0.95 | 1.50 | 1.30 | 1.10 | 0.95 | 1.30 | 1.10 | 1.00 |
| 14 | 0.85 | 1.30 | 1.10 | 0.80 | 0.60 | 1.30 | 1.00 | 0.60 |
| 15 | 0.75 | 1.40 | 1.20 | 1.00 | 0.90 | 1.30 | 0.90 | 0.80 |

Table 10. The ordered array of treatment means of the trunk diameters in centimeters measured at trunk base, 6 inches above base, and 12 inches above base of Elberta and Redhaven peach trees, 1957 planting.

| Elberta | | Redhaven | |
|---|---|---|---|
| Group | Mean | Group | Mean |
| | | **Base** | |
| III | 0.50 | III | 0.50 |
| | | | ns |
| II | 0.49 | II | 0.40 |
| | | | * |
| I | 0.35 | I | 0.21 |
| L.S.D. at 5% | ns | | 0.17 |
| | | **6 in. height** | |
| III | 1.12 | III | 1.02 |
| | ns | | * |
| II | 1.06 | I | 0.92 |
| | * | | ns |
| I | 0.92 | II | 0.86 |
| L.S.D. at 5% | 0.12 | | 0.10 |
| | | **12 in. height** | |
| III | 0.92 | III | 0.82 |
| II | 0.80 | II | 0.72 |
| I | 0.68 | I | 0.70 |
| L.S.D. at 5% | 0.14 | | ns |

No significant difference was found between the trunks of trees of groups II and III. The mean trunk diameter 6 inches above the base was significantly larger in the trees of group III as compared to the trees of groups I and II. There were no significant differences in the trunk diameters among the trees of the treatment groups 12 inches above the base of the trunk.

The primary shoots were considered to be any growth originating from the trunks of the trees. The secondary shoots were any growth originating from the primary shoots. The longitudinal growth of the secondary shoots was variable as shown in Table 11.

Table 11. Length in centimeters of primary and secondary shoots of Elberta and Redhaven peach trees, 1957 planting.

| Tree No. | Elberta | | Redhaven | |
|---|---|---|---|---|
| | Primary | Secondary | Primary | Secondary |
| | | Group I | | |
| 1 | 288.5 | 68.0 | 489.5 | 19.5 |
| 2 | 258.0 | 21.5 | 330.5 | 62.0 |
| 3 | 290.5 | 22.0 | 394.0 | 20.5 |
| 4 | 292.5 | 8.5 | 289.0 | 48.5 |
| 5 | 288.0 | 0.0 | 335.0 | 0.0 |
| | | Group II | | |
| 6 | 348.5 | 6.0 | 453.5 | 29.0 |
| 7 | 317.0 | 108.0 | 357.0 | 21.5 |
| 8 | 259.0 | 41.0 | 593.5 | 22.5 |
| 9 | 329.0 | 110.0 | 308.0 | 100.0 |
| 10 | 385.0 | 0.0 | 356.0 | 337.5 |
| | | Group III | | |
| 11 | 375.5 | 174.5 | 541.0 | 55.5 |
| 12 | 477.5 | 30.0 | 485.5 | 306.5 |
| 13 | 263.0 | 331.5 | 461.5 | 100.5 |
| 14 | 389.0 | 138.5 | 659.0 | 37.5 |
| 15 | 369.0 | 225.5 | 442.0 | 57.0 |

Analysis of the primary and secondary shoot measurements, however, revealed little significant differences in average length among the treatment groups (Table 12). The secondary shoots of the Elberta trees of group III were found to be significantly longer

Table 12. The ordered array of treatment means of length of primary and secondary shoots in centimeters of Elberta and Redhaven peach trees, 1957 planting.

| | Primary shoots | | Secondary shoots | |
|---|---|---|---|---|
| | Elberta | Redhaven | Elberta | Redhaven |
| Group | Mean | | Mean | |
| III | 374.80 | 517.80 | 180.00 | 111.40 |
| | | | * | |
| II | 327.70 | 413.60 | 53.00 | 102.10 |
| | | | ns | |
| I | 283.50 | 367.60 | 24.00 | 30.10 |
| L.S.D. at 5% | ns | ns | 100.23 | ns |

than those of groups I and II. This was the only significant difference noted in shoot length.

The average dry weights of the primary and secondary shoots of groups II and III were significantly higher than those of group I for both the Elberta and Redhaven trees (Table 8). The dry weight of shoots of the Elberta and Redhaven trees in group III was not significantly higher than group II.

The differences in the dry weight of the roots were not significant for either variety among the treatment groups (Table 8).

## DISCUSSION

The dry weight of the trunks was significantly higher in all treatment groups of the Redhaven trees grown at the high soil moisture level when compared to trees grown at the low soil moisture level. A significant reduction in dry weight of trunks was noted when more than 50 percent of the available moisture was utilized by the trees. Apparently the optimum soil moisture level

EXPLANATION OF PLATE IV

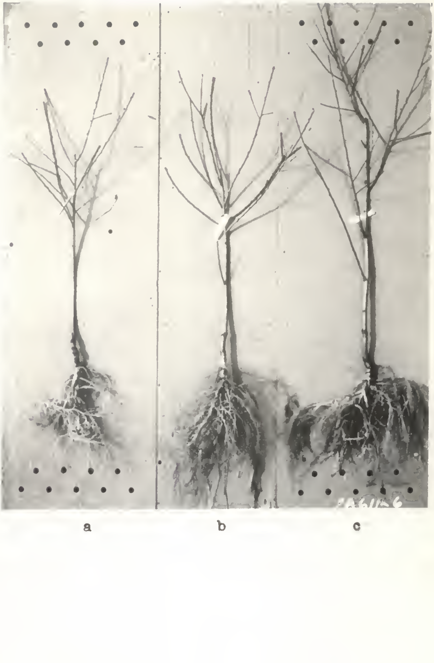
Representative Elberta trees from the 1957 planting of the various treatment groups:

a. Group I

b. Group II

c. Group III

PLATE IV



a b c

## EXPLANATION OF PLATE V

Representative Redhaven trees from the 1957 planting of the various treatment groups:

a. Group I

b. Group II

c. Group III

PLATE V

a b c

EXPLANATION OF PLATE VI

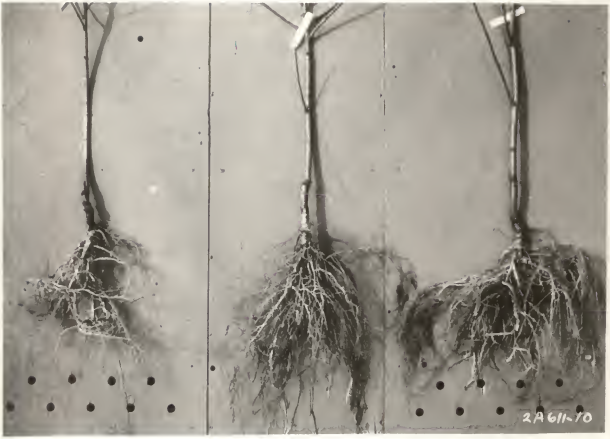
Representative Elberta trees of the 1957 planting, showing roots and trunks from the various treatment groups:

a. Group I

b. Group II

c. Group III

PLATE VI




a b c

## EXPLANATION OF PLATE VII

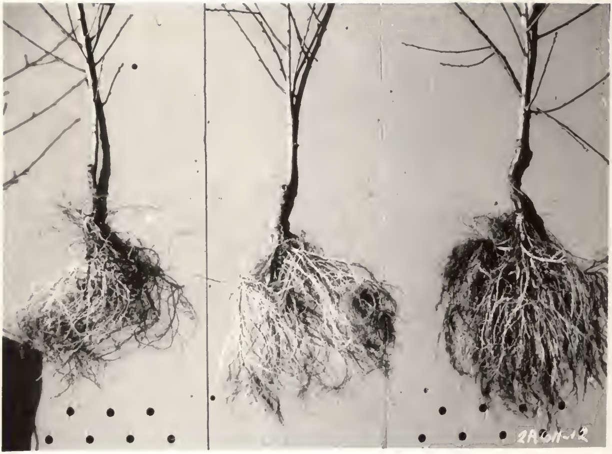
Representative Redhaven trees of the 1957 planting, showing roots and trunks from the various treatment groups:

a. Group I

b. Group II

c. Group III

PLATE VII



a b c

for trunk growth of the Redhaven trees is in a range above 50 percent of the available soil moisture supply.

The dry weight of the trunks of the Elberta trees was not significantly different in the treatment groups of the 1956 planting. The Elberta variety was apparently less affected by the differences in soil moisture levels. This may be due to varietal characteristics or to some other factor or factors not apparent. The average dry weights of trunks of the Elberta trees in the 1957 planting were significantly greater in the two higher soil moisture treatment groups when compared to trees growing at the low soil moisture level. Further investigations are needed to clarify the differences in results shown by this variety in 1956 and 1957.

The diameter of trunks measured at the base of the Redhaven trees was significantly smaller in the low soil moisture treatment groups when compared to higher soil moisture treatment groups. The limiting factor in trunk diameter growth in the low soil moisture treatment groups was apparently the limited quantity of water applied. The higher levels of soil moisture could be considered optimum for trunk growth in the Redhaven variety.

The average diameter of trunks at the base of the Elberta trees was not significantly different among the soil moisture treatment groups. This could be due to a varietal characteristic of the Elberta variety or to other factors not evident in this experiment.

The diameters of the trunks measured 6 and 12 inches above the base were compared among the soil moisture treatment groups of the 1957 planting at the end of the growing season. The trunk diameter of the Elberta trees was increased significantly at the 6-inch measurement when the soil moisture level was increased from the low level to a higher level. Trunk diameters increased significantly at the 12-inch measurement when the soil moisture level was increased from the low level to the highest level. The diameter of trunks of the Redhaven trees increased significantly 6 inches above the base in the trees grown at the high soil moisture level. No increase was evident in the measurements taken 12 inches above the base of the trunk.

The high soil moisture level increased the diameter of the trunks of the Redhaven trees in the lower regions of the trunk area; whereas this level increased the diameter of the trunks of Elberta trees in the upper regions of the trunk area.

A study of the results indicate the shoots of the Redhaven trees were significantly larger in all high moisture treatment groups than those growing in low moisture treatment groups. Except for the 1957 planting, the shoots of all Redhaven trees receiving the high moisture treatments were significantly larger than those receiving the medium moisture treatments. The dry weight of the Elberta shoots was significantly increased in the 1957 planting in groups II and III when compared to group I, trees receiving the low moisture treatment. The above findings are in agreement with the results reported by Kenworthy (13). He found the dry weight of the shoots of apple whips significantly reduced when 80 percent of the available soil moisture was depleted.

The dry weight of the Elberta shoots in the 1956 planting was not significantly greater in the trees receiving the high moisture treatment than in those receiving the low moisture treatment in 1956. All the trees in the 1956 planting were grown at a high moisture level in 1957. It was stated previously that the dry weights of shoots of the Elberta trees in the 1957 planting were significantly greater in trees receiving the high and medium moisture treatments than in those of the low moisture treatment (group I). No definite proof is available that the higher soil moisture level in 1957 did have an influence on dry weight of the shoots of the Elberta trees of the 1956 planting. However, it is possible the additional moisture in 1957 enabled all trees to attain approximately the same sizes.

It appears from the results of this experiment that the dry weight of the shoots of the Redhaven trees was increased by the higher levels of soil moisture. The evidence indicating a like response in the shoots of the Elberta trees is inconclusive.

There was no significant difference in length of shoots of the Redhaven trees in the 1957 planting. It seems logical to assume the diameter of shoots was larger and would account for the increased dry weight of the shoots of the trees grown at the higher soil moisture levels in the 1957 planting. The significantly greater number of shoots in the high soil moisture treatment of the 1956 Redhaven planting would account for the increased dry weight of the shoots when compared to the low soil moisture treatment.

The length of the primary shoots of the Redhaven and Elberta shoots in the 1957 planting was not significantly increased by growing trees at high soil moisture levels when compared to those grown at low soil moisture levels. Allmendinger, et al. (2) reported a reduction in terminal elongation of apple shoots when more than three-fifths of the available soil moisture had been removed from the soil. Simons (21) reported a reduction in terminal growth of apple shoots when he compared a low moisture treatment to a high moisture treatment.

The secondary shoots of the Elberta trees were significantly longer in group III when compared to group I, and in group III when compared to group II. It is noted in Table 11 that the total length of the secondary shoots of the individual trees within a treatment group varied greatly, especially in groups I and II. Keeping the soil moisture level above 50 percent of the available supply produced a more uniform and greater average length of secondary shoot growth in the individual trees of group III of the Elberta variety than in the other treatment groups.

The lengths of the secondary shoots of the Redhaven trees were not significantly different among the treatment groups of the 1957 planting. A considerable variation in the length of the secondary shoots of the individual trees within a treatment group was evident in this variety also (Table 11).

The Redhaven trees in the high moisture treatment of 1956 grown in 1956 and 1957 had a significantly greater number of shoots as compared to those in the low moisture treatment. This was apparently due to the greater availability of soil moisture in the soil in which the trees were grown. The trees in the low moisture treatment were grown in a soil that received only a limited application of water each time of watering in 1956 but were grown at a high soil moisture level in 1957. The high level of soil moisture in 1956 apparently influenced the initiation of shoots. Primary and secondary shoots were considered in this analysis.

There was no significant difference in number of shoots between the low and high treatment groups of the Elberta trees in the 1956 planting grown in 1956 and 1957. Analysis of the 1957 terminal growth also showed no significant differences in length or diameter of the terminal shoot growth in any of the treatment groups of this variety. The Elberta variety apparently was less affected by the different soil moisture levels than was the Redhaven variety when shoot growth and shoot number were compared.

The Redhaven trees in the 1956 planting grown at a low moisture level in 1956 and high moisture level in 1957 had significantly greater average length, total length, and average diameter in terminal shoot growth when compared to the trees grown at the high moisture level in both 1956 and 1957; however, the total diameter of the terminal growth was significantly larger in the trees of the treatment group grown at a continuous high level of soil moisture. This can be explained by the larger number of shoots on the trees of the high moisture treatment group as discussed previously. This was more pronounced when the average number of shoots of the low and high treatments were compared (Table 4). The average number of shoots per tree in the low moisture treatment group was 24, and the average number of shoots per tree in the high moisture treatment group was 38.

The dry weight of the roots was less affected than that of the trunks and shoots when the trees were grown at the various soil moisture levels. The average dry weight of roots in the high and medium moisture treatment groups was increased significantly when compared to the trees in the low moisture treatment group of the Redhaven trees in the 1956 planting that were removed at the end of that growing season. The average dry weight of the roots in the high moisture treatment group was not significantly different from those in the medium moisture treatment group. Analysis of the Elberta and Redhaven trees in the 1956 planting grown at a high soil moisture level in 1957 revealed no significant differences in the dry weight of roots, although the roots of the Redhaven trees grown at the high moisture level in 1956 barely missed being significantly larger than those grown at the low moisture level. In the 1957 study the roots of the Redhaven trees of group III were distinctly larger than those of group I although these differences were not quite significant. Analysis of the Elberta trees in the 1957 planting showed no significant differences in the dry weight of the roots among the moisture treatment groups.

An inherent difference in varietal response to different soil moisture levels was noted.

The trees of the Redhaven variety were more responsive to moisture increases than were those of the Elberta variety. This was reflected by the proportionately greater size of roots as compared to the shoots and trunks. As indicated above, the influence of the variable moisture levels on root growth of the Redhaven trees varied during the two years of study. Further studies are needed to determine the causes of the differences in root growth noted between the two years studies.

Meyer and Anderson (18) stated, in general, a relatively low soil-water content and adequate soil aeration favor relatively low shoot-root ratios, while the opposite conditions favor relatively high ones. The shoot-root ratios for the Elberta and Redhaven trees are found in Table 13. The ratio increased as the soil moisture level increased, indicating greater shoot development at the higher soil moisture level compared to a like increase in the root growth. Dry weight of the roots of the Elberta and Redhaven trees was not significantly different among the treatment groups except in the Redhaven trees removed in 1956. A significant increase in shoot dry weight was found in this experiment when a higher moisture level was compared to the low level. An exception to this preceding statement was found in the analysis of the Elberta trees of the 1956 planting. It is noticed in the table of shoot-root ratios that the ratio for the Elberta trees in that planting was low. Apparently, under conditions of this experiment, the higher soil moisture levels produced a greater average dry weight of the shoots while average dry weight of the roots did not increase at a comparable rate.

When the trees were removed from the boxes, it was observed that root growth had permeated the soil thoroughly. It was also noted that roots of the trees in the low moisture treatment groups had a rather heavy concentration of the finer adventitious roots in the upper portion of the soil. The heavy concentration of roots

Table 13. Shoot-root ratios, based on average dry weights of shoots and roots of Elberta and Redhaven peach trees grown at three levels of soil moisture.

| Treatment group | Elberta | | | Redhaven | | |
|---|---|---|---|---|---|---|
| | Shoots | Roots | S/R ratio | Shoots | Roots | S/R ratio |
| | | | Trees grown in 1956 | | | |
| High | | | | 109.3 | 131.0 | .83 |
| Medium | | | | 68.8 | 111.6 | .61 |
| Low | | | | 31.7 | 67.6 | .47 |
| | | | Trees grown in 1956 and 1957 | | | |
| High | 159.3 | 316.6 | .50 | 207.1 | 327.5 | .63 |
| Low | 134.4 | 290.9 | .46 | 135.1 | 266.1 | .50 |
| | | | Trees grown in 1957 | | | |
| Group III | 32.0 | 73.7 | .43 | 36.9 | 108.9 | .34 |
| Group II | 27.0 | 73.6 | .36 | 30.5 | 82.6 | .37 |
| Group I | 18.4 | 58.2 | .31 | 19.4 | 75.8 | .25 |

in the upper limits of the soil was probably due to the limited depth in the soil to which water penetrated in the low moisture treatments. It is possible the adventitious root growth was great enough in the moist region of the soil mass to overcome the decrease in secondary root development as well as the water deficit in the lower portion of the soil mass. This might account for the failure of dry weights of the roots of the Elberta trees and the 1957 planted Redhaven trees to vary significantly between treatment groups.

The observation of Rogers (19) that soil moisture appears to act as a limiting factor in root growth well before the wilting range is reached was supported by the significant increases in dry weights of roots of the Redhaven trees grown at the higher soil moisture levels during the 1956 growing season. A similar relationship was observed with trees of this variety in 1957; however, the differences were not significant.

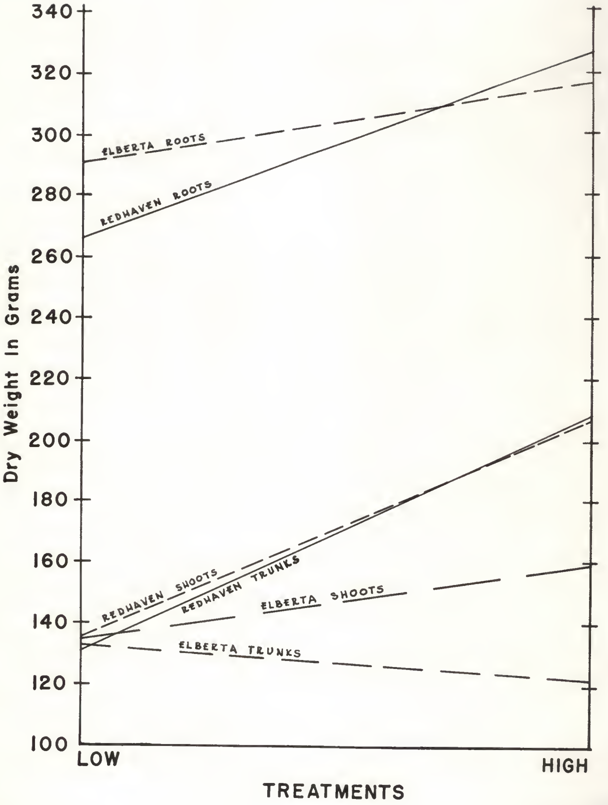
The line graph (Plate VIII) shows a comparison in the average total dry weight of the component parts of the Elberta and Redhaven trees of the 1956 planting, grown in 1956 and 1957. The average dry weight of the trunks of the Redhaven trees is in rather sharp contrast to trunk weights of the Elberta trees. The dry weight of the shoots was significantly greater in the Redhaven trees grown in the high moisture treatment as compared to trees receiving the low moisture treatment. The average dry weights of the shoots of the Elberta trees increased from low to the high moisture treatment but not significantly. The average dry weight increase of the Redhaven roots was greater than that of the Elberta trees; however, the differences weren't significant.

There appeared to be a varietal difference in the growth of the trunks and shoots. The higher soil moisture level is optimum for trunk and shoot growth in the Redhaven variety. Trunk and shoot growth in the Elberta variety was apparently not affected to the same degree by the difference in the soil moisture level. It is apparent the low soil moisture level retards vegetative growth of the above ground tree parts in the Redhaven variety. Soil moisture levels had no significant effect on the differences in growth of the above ground tree parts in the Elberta variety under the conditions of this experiment. Elberta trees were not removed and sampled at the end of 1956, thus an accurate explanation cannot be

EXPLANATION OF PLATE VIII

Average of the total dry weight of vegetative growth of Elberta and Redhaven peach trees in the low and high moisture treatments, 1956 planting, grown in 1956 and 1957.

PLATE VIII



340
320
300
280
260
240
220
200
180
160
140
120
100
Dry Weight In Grams
ELBERTA ROOTS
REDHAVEN ROOTS
REDHAVEN SHOOTS
REDHAVEN TRUNKS
ELBERTA SHOOTS
ELBERTA TRUNKS
LOW
HIGH
TREATMENTS

given to account for these results.

Growth of the roots in both varieties was not significantly different with respect to soil moisture levels, although the Redhaven tree roots approached significance at the high soil moisture level. It is possible that soil aeration could be a limiting factor in this portion of the experiment. The trees were grown under conditions that would not be found in the field. The soil boxes were lined and the box tops were covered tightly. Free exchange of carbon dioxide and oxygen in the soil may have been disrupted. This would be more pronounced at the higher soil moisture levels. Soil temperature may also be a limiting factor in root growth. Rogers (19) reported a decreased rate of root growth in apple trees when soil temperatures were above 69 degrees Fahrenheit.

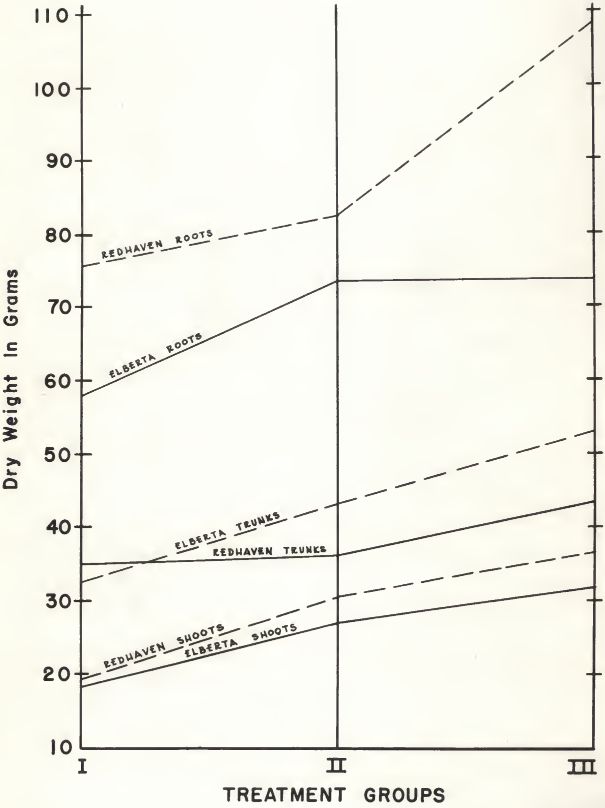
The line graph (Plate IX) shows a comparison of the average dry weights between the Elberta and Redhaven varieties in the 1957 planting.

The dry weight of the trunks of the Elberta and Redhaven varieties shown in Plate IX are in sharp contrast with the dry weights shown in Plate VIII. The Elberta trees show a continuous increase in the dry weight of the trunks with respect to all soil moisture groups. This increase was significant in the treatment groups II and III when compared to treatment group I. The Redhaven trees show an increase in the dry weight of the trunks with an increase in moisture level. This increase was significant between groups I and III, and groups II and III. As would be expected, the maximum trunk growth was found in the Elberta and Redhaven trees grown at the high level of soil moisture. This would appear to be the

EXPLANATION OF PLATE IX

Average of the total dry weight of vegetative growth of Elberta and Redhaven peach trees in group I, group II, and group III, 1957 planting.

PLATE IX


110
100
90
80
70
60
50
40
30
20
10
Dry Weight In Grams
REDHAVEN ROOTS
ELBERTA ROOTS
ELBERTA TRUNKS
REDHAVEN TRUNKS
REDHAVEN SHOOTS
ELBERTA SHOOTS
I
II
III
TREATMENT GROUPS

optimum level for both varieties.

The increase in the average dry weight of the shoots of the Elberta and Redhaven trees was similar when treatment groups were compared. The high level of soil moisture could be considered optimum for shoot growth for both varieties. The shoot growth was significantly decreased in both varieties grown at the low level of soil moisture when compared to those grown at the higher levels.

An increase in the average dry weight of roots is noticed for both varieties between groups I and II. The dry weight of the roots in the Redhaven variety increased rather sharply compared to the Elberta variety between treatment groups II and III. The differences among treatment groups were not significant although the Redhaven trees again approached significance.

## SUMMARY

1. One-year-old Elberta and Redhaven peach trees used in the experiment were grown in wooden boxes containing field soil at three controlled soil moisture levels: a low, medium, and high level.

2. a. A difference in varietal responses to the various soil moisture levels was noted in those trees planted in 1956.

b. Trees of the Redhaven variety grown in 1956 at low soil moisture levels and in 1957 at high moisture levels were significantly smaller as shown by dry weights of trunks and shoots than trees of this variety grown at the high soil moisture levels both years.

c. The average number of shoots produced by the Redhaven trees grown in 1956 at low moisture levels was significantly smaller than the number produced in the high moisture treatments.

d. When some Redhaven trees of each moisture treatment group were removed from the test at the end of the 1956 growing season, significant increases in dry weights were noted with each increase in moisture for the trunks and shoots. Roots of the trees growing at medium and high moisture levels were significantly larger than those of the low moisture group but differences in root size between the two higher moisture treatments weren't significant.

e. The roots of both varieties grown both years at the high soil moisture levels were larger than those grown at low moisture levels in 1956, and at high levels in 1957 although these differences weren't significant.

f. There were no significant differences in vegetative growth of Elberta trees of the 1956 planting subjected to the same treatments.

3. a. Average dry weights of the trunks of the Redhaven variety of the 1957 planting increased significantly in trees grown at the high soil moisture level as compared to trees grown at lower soil moisture levels. Diameter of trunks measured at the base of the trees was significantly greater in the Redhaven trees grown at higher levels of soil moisture as compared to those grown at the low levels.

b. Length of primary shoots was not significantly different in Redhaven trees when soil moisture treatment groups were compared in 1957.

c. Average dry weights of the roots of the Redhaven peach trees were not significantly different between any of the moisture levels.

4. a. A significant increase was found in the dry weight of trunks and shoots of the Elberta trees in the 1957 planting grown at the higher soil moisture levels when compared to the low soil moisture level. The average weights of the roots of the plants grown at the higher moisture levels were also greater but the differences weren't significant.

b. Length of secondary shoots of the Elberta trees was significantly greater in the higher soil moisture treatment groups compared to the low soil moisture treatment groups in the 1957 planting. Length of primary shoots was not significantly different in the Elberta trees when soil moisture treatment groups were compared either year.

5. Trees of the Elberta variety were less responsive, in general, to the varying soil moisture levels in the 1956 planting than were Redhaven trees. However, in 1957 both varieties reacted similarly to the soil moisture treatments.

6. a. Further studies are needed to clarify the differences shown by the Elberta variety when the results of the 1956 and 1957 plantings were compared; also to clarify the differences shown in the average dry weight of roots of the Redhaven trees removed in 1956 and those of the 1957 planting where moisture treatments were essentially alike.

b. Under conditions of this experiment the high level of soil moisture could be considered the optimum level for maximum vegetative growth in both varieties.

ACKNOWLEDGMENT

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The author wishes to thank Dr. H. C. Fryer for the supervision of the statistical analysis and his very helpful explanations in the interpretation of the results.

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# VEGETATIVE GROWTH OF ELBERTA AND REDHAVEN PEACH TREES AS INFLUENCED BY SOIL MOISTURE VARIATIONS

by

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ABSTRACT OF A THESIS

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Elberta and Redhaven peach trees were grown at three levels of soil moisture to study the effect of the various soil moisture levels on the vegetative growth of the trees. The trees were planted in wooden boxes that contained approximately 160 pounds of field soil per box.

A total of 27 one-year-old trees of each variety were planted in 1956. These trees were divided into three treatment groups of nine trees of each variety per treatment. The treatments were designated as the low, medium, and high soil moisture treatments. The moisture supply was determined by use of plaster of paris resistance blocks and a moisture detector. The medium soil moisture treatment was removed at the end of the 1956 growing season. Trees of the low and high soil moisture treatment groups were grown in 1957 at a high soil moisture level. A planting of 18 one-year-old trees of each variety was made in 1957. The soil moisture treatments were essentially the same as in 1956.

Trees of the low soil moisture treatment groups were permitted to show visible wilting before a limited quantity of water (one gallon) was applied. The soil moisture level of the medium treatment groups was permitted to reach the wilting range; water was then added, bringing the soil moisture level to the moisture equivalent. The high soil moisture treatment groups received applications of water in order to maintain the soil moisture content at or near the moisture equivalent.

There were no significant differences in the vegetative growth of the Elberta trees among the various soil moisture treatments of the 1956 planting.

The trunks and shoots of the Redhaven trees removed in 1956 had a significantly higher average dry weight in those trees grown at the high soil moisture level when compared to the trees grown at the lower soil moisture levels. Average dry weight of the roots of the Redhaven trees was significantly greater in the trees grown at the higher soil moisture levels when compared to the trees grown at the lowest soil moisture level.

The trunks and shoots of the Redhaven trees of the 1956 planting, grown in 1956 and 1957, were significantly greater in the average dry weight at the higher soil moisture levels as compared to the lowest soil moisture level. No significant differences were found in the average dry weight of the roots.

The average number of shoots produced by the Redhaven trees growing in the high soil moisture treatment was significantly larger than those of the trees growing in the low soil moisture treatment. No significant differences were found in the average number of shoots of the Elberta trees among the soil moisture treatments.

The shoots and trunks of Elberta and Redhaven trees in the 1957 planting were significantly higher in average dry weight in the higher soil moisture treatments when compared to the trees grown in the low soil moisture treatment. No differences were found in the average dry weight of the roots of either variety when treatment groups were compared. There were no significant differences found in length of primary shoots in either variety among the treatment groups of the 1957 planting although the Elberta trees grown in the higher soil moisture treatment groups had a significantly greater total length of secondary shoots as compared to the trees grown in the low soil moisture treatment group.