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To the Graduate Council:

I am submitting herewith a thesis written by John Morgan Matthews, Jr., entitled "The Effects of Two Levels of Nitrogen Fertilization and Pruning and Four Weed Control Treatments on the Growth and Yield of Twelve Cultivars of Peaches." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Horticulture.

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and recommend its acceptance:

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THE EFFECTS OF TWO LEVELS OF NITROGEN FERTILIZATION AND PRUNING AND FOUR WEED CONTROL TREATMENTS ON THE GROWTH AND YIELD OF TWELVE CULTIVARS OF PEACHES

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

John Morgan Matthews, Jr.

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ABSTRACT

A study was carried out from 1967 to 1970 to determine how twelve peach (Prunus persica) cultivars respond to two levels of nitrogen fertilization, two levels of pruning, and four weed control treatments with respect to yields and growth of the tree.

Yield of fruit was recorded in 1969. Trunk diameters were recorded in 1967, 1968, and 1969 and pruning weights were recorded in 1968, 1969, and 1970. Leaf samples were taken for analysis in 1968 and 1969.

The high rate of nitrogen increased yields and delayed maturity but there were no differences in the yield of the twelve cultivars.

There were differences in the trunk diameter and pruning weights of the twelve cultivars. Nitrogen influenced the trunk diameter and pruning weights and weed control treatments influenced the trunk diameter. Pruning and nitrogen interacted with respect to the trunk diameter and pruning weights.

Foliar analysis showed that the level of nitrogen in the leaves was low.

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CHAPTER I

INTRODUCTION

The field of mineral nutrition is an important one for the maximum production of quality peaches because the peach (Prunus perscia) is grown so widely and under such varying conditions. In addition to yields, moderately vigorous shoot growth is needed each season in order to maintain good fruit production. Careful manipulation of fertilization, cultivation, and pruning practices will help achieve this. Interrelationships exist between the various cultural practices and affect fruit production. How peaches respond to the interaction of fertilization, pruning, and weed control practices is of importance to the people who grow peaches commercially.

In most peach growing sections annual applications of nitrogen-containing fertilizers are needed to maintain good tree growth and high yields. The nitrogen status of peach trees is affected by many cultural practices besides the application of nitrogen itself. Different degrees of pruning severity, yield and water supply, as well as soil management practices can alter and influence the nitrogen level of peach trees.

The objective of this investigation was to study the response of peaches to two levels of nitrogen fertilization, two levels of pruning, and four weed control treatments and their interactions and foliar nutrient content with respect to yields and growth of trees.

CHAPTER II

REVIEW OF LITERATURE

I. EFFECTS OF NITROGEN FERTILIZATION

In regions where annual rainfall is at least 20 inches and particularly if the soil is sandy, leaching may reduce the available nitrogen supply. This coupled with vigorous uptake of nitrogen by peach trees makes nitrogen the commercially key nutrient used to maintain growth and fruiting in the peach. Effects of nitrogen on the production of peaches is reported by many workers.

Fruit Yields

Many investigators (17, 24, 45, 47, 54, 57, 63, 71) report increased yields due to the use of different amounts and different carriers of nitrogen. In most nitrogen experiments with peaches, increased yields have occurred as a result of increased size of individual fruits and increased set of fruit. Blake (5) reported that nitrogen fertilized Elberta trees growing in a light soil in New Jersey yielded almost twice as much fruit as the unfertilized check and that no "June drop" occurred. Mowry (51) applied four levels of nitrogen (1/8, 1/4, 1/2, and 1 pound of NH_4NO_3 per year of tree age) to orchard trees and found that the more nitrogen applied, the greater increase in number and weight of fruit. Mowry concluded that the main response was an increase in fruit size. However, Cowart and Savage (16) found in their experiments with Elberta peaches in Georgia that unless thinning was used, the amount of nitrogen applied apparently had no effect on fruit size.

Havis and Gourley (27) studied the effects of various nitrogen carriers on peach trees and concluded that the use of nitrogen fertilizer in any form applied at any time increased the set of fruit over unfertilized trees. Cooper (14) is in agreement.

Fruit Quality

Several studies have shown that red coloration of peach fruits usually decreases with increasing amounts of nitrogen used (16, 17, 26, 45, 52). This is usually attributed to greater and denser foliage cover which shades the fruit.

These investigators and others (5, 47, 51, 65) report that a delay in ripening usually accompanys decreased coloration of fruit when nitrogen is used on peach trees, especially where relatively large amounts have been used. Nitrogen promotes vegetative growth with a subsequent decrease in the level of carbohydrates in the tree that can be assimilated by the fruit.

Degman (19, 20) found no significant differences in firmness or keeping quality of fruit regardless of whether trees were fertilized with nitrate of soda or left unfertilized. However, Proebsting et al. (60) reported that the canning quality of Elberta peaches was improved by nitrogen applications indicating that firmness may be influenced by nitrogen. This possibly could be explained by Reeve and Neufeld (61) who found that peaches from high nitrogen fertilized trees had more and smaller flesh parenchyma cells. This suggests that the size of fruit in each nitrogen status could be determined by the number of cells per fruit rather than by the size of the cells.

Ashley (2) and Lott (44) also found that an increase in rate of nitrate application was associated with a decrease in percentage of reducing and total sugars in the fruit.

Tree Growth

Nitrogen fertilizers will stimulate growth responses in plants, particularly peach trees. These trees will respond in several ways.

Many investigators (8, 15, 52, 53, 59) have found that terminal shoot growth is stimulated by increasing amounts of nitrogen fertilization. Ashley (2) and Lott (45) determined the effect of nitrate of soda on vegetative growth of peach trees using 3, 6, 9, and 12-pound applications and found that trees which received 12 pounds made the most shoot growth. Leaf area, leaf dry weight, and total nitrogen increased in shoots with an increase in nitrogen. Cullinan (18) found that trees which had received no nitrogen had made less shoot growth than nitrogen-treated trees when examined six weeks after petal fall. Terminal growth of the unfertilized trees stopped by mid-summer and was about one-third as long as that on trees receiving 6 pounds of nitrate of soda.

Smith (68) noted that in Kansas nitrogen is the only element needed in most soils and if terminal shoot growth of young peach trees is greater than 18 inches, no fertilizer is needed. Johnston and Larsen (33) indicated that 12 inches of growth is sufficient to maintain good production and vigor in Michigan.

In other growth studies, Lagasse (41) found that trees which had received nitrogen fertilizer produced more foliage than trees which were not fertilized. Overcash et al. (53) reported that the presence of

nitrogen in fertilizer material resulted in darker green leaf color and delayed defoliation of trees in the fall.

A method for determining the growth of peach trees has been to measure the trunk diameter or circumference. Investigators (1, 16, 29) in Georgia have reported in experiments with Elberta peaches that there appeared to be almost a direct correlation between trunk size and amount of nitrogen applied. Trunk growth was smallest on trees receiving no nitrogen. Crane (17) studied Elberta growth and yield for several years and reported the following results: (a) there was a fair degree of correlation between gain in trunk circumference and yield of fruit and (b) linear primary shoot growth and gain in truck circumference was closely correlated with yield. It was concluded that length of primary terminal shoots and gain in trunk circumference, used singly or together, would be valuable aids in measuring response of peach trees to varying treatments.

Kenworthy and Gilligan (38) reported a positive correlation of leaf nitrogen with trunk circumference.

II. EFFECTS OF PRUNING TREATMENTS

According to Marshall (49), pruning has two major functions in the peach orchard: (a) to train the tree, preventing wood from becoming too far removed from the trunk and (b) thinning the crop, thus influencing the size of fruit and total yield. In order to make a practical evaluation of a pruning method, factors such as fruit size, yield, quality and color, as well as vegetative growth must be considered (73).

Fruit Yields and Quality

Cain and Mehlenbacher (10) found that heavy pruning reduced the yield of peaches and attributed this to limiting the amount of bearing wood and, thereby, the number of fruit per tree. The yield of heavily pruned trees was improved by reducing the severity of pruning and employing larger amounts of nitrogen fertilizer. Overcash et al. (54) found that doubling the amount of fertilizer per tree did not increase yields on heavily pruned trees. Harman (25) reported that trees receiving medium light pruning and thinning produced about 60 per cent more fruit of good commercial size than similar trees receiving the same degree of thinning but medium heavy to heavy pruning. However, Blake (6) feels that 35 to perhaps 40 per cent of the total annual growth can be removed without greatly reducing the yield.

Schneider and McClung (65) and Schneider et al. (66) studied the relationship of nitrogen application (0.3, 0.6, 0.9, and 1.2 pounds of nitrogen per tree per year) and level of pruning severity with Halehaven peaches. There was an interaction of pruning and rate of nitrogen since the lightly pruned trees benefited from each increment of nitrogen up to 1.2 pounds, but the medium and heavily pruned trees did not. Increase in pruning severity and rate of nitrogen application also delayed ripening and decreased red coloration of the fruit. Increases in nitrogen application did not affect fruit size but heavy pruning resulted in an increase in size.

Morris et al. (50) concluded that control of fruit load should be accomplished by fruit thinning.

Tree Growth

Schneider and McClung (65) found that increases in the rate of nitrogen application and increases in pruning severity produced greater terminal growth and an increase in foliar nitrogen. Ballinger et al. (3) reported that increases in nitrogen application slightly increased terminal growth, trunk area, and weight of pruning wood whereas heavier pruning resulted in longer terminal shoot growth and greater weight of pruning wood with no effect on trunk growth. Schneider and Correll (64) found that increasing the pruning severity resulted in increased length of growth per terminal and an increase in the fresh weight of leaves.

III. EFFECTS OF SOIL MANAGEMENT TREATMENTS

Peach orchard soil management should be aimed at reducing weed and grass growth under the trees early in the season to allow good tree growth, maintaining soil tilth, and preventing soil erosion (33). Management practices can affect both yields and quality of fruit as well as tree growth.

Sod, Cover Crops and Cultivation

Ford and Judkins (21) grew Halehaven peach trees under a sod (clover and grass) and clean cultivation on a deep, well-drained Wooster silt loam soil and applied four levels of nitrogen. The fruit's green pigment content was measured and it was found that more pigment produced as the amount of nitrogen application increased on the clean cultivated trees.

Harris and Boynton (26) found that a late cultivation with no cover crop produced fruit that was greener, firmer, and ripened later than that from trees under clean cultivation with an early sowing of a grass cover crop. This treatment also induced the greatest terminal shoot growth, heaviest pruning wood weights, and the largest leaf size.

Proebsting (58) indicates that sod is a strong competitor with trees for nitrogen. He found in experiments with Elberta peaches that with permanent cover crops, the yield was low, growth was reduced, and the fruit was highly colored and early in ripening. Chhonkar, cited by Childers (12), believed that twice as much nitrogen was needed for peach trees in sod as that needed for clean cultivated trees to achieve the same growth, yield, and leaf content.

Moisture is also an important factor as mentioned by Hill (30) who believed that peach trees could be grown successfully in sod if enough moisture and nutrients are provided. Judkins (34) and Wander (35) indicated that soil moisture appeared to be a more important factor than nitrogen in the growth of one-year peach trees. During seasons when soil moisture was not limiting, however, the trees made as good growth under sod as under clean cultivation.

Pickett (55, 56) reported a 47 per cent greater bloom on trees of the J. H. Hale cultivar under clean cultivation than those in cowpea cover plots. Also trees fertilized with nitrate of soda in clean-cultivated plots produced 26 per cent more bloom than the trees receiving no nitrogen whereas in the cowpea cover plots, nitrogen fertilized trees produced only 15 per cent more bloom than nonfertilized trees.

Herbicides

In 1960, Larsen and Ries (42) reported that growth of young apple and peach trees in treatments with 2-chloro-4,6-bis(ethylamino)-s-triazine (simazine) was greater than trees in untreated checks. It was not indicated if this was due to the control of weeds or to a stimulus by the herbicide.

In a later study, Ries et al. (62) found that peach trees treated with a mixture of simazine and 1,2,4,-trazine plus ammonium thiocyanate (amitrole-t) had a higher level of leaf nitrogen, longer terminal growth, and more lateral branches than those trees where weeds were controlled by hand hoeing or black plastic mulch. A growth stimulus was provided in excess of just reducing weed competition.

In a study with citrus trees, Goren et al. (23) observed the effects of amitrole and simazine and found that amitrole had no effect but simazine alone enhanced growth of trees, total and protein nitrogen and chlorophyll in leaves, and slightly depressed dry matter content.

However, in a study in 1967, Lord et al. (43) reported that simazine did not alter the chemical composition of the leaf or affect growth, fruit size and yield of Jerseyland peaches when compared with plots where weeds were controlled by other treatments. There is also evidence that simazine does not injure the growth and production of fruit trees (22).

IV. FOLIAR ANALYSIS

Principles

Leaf analysis, based on appropriate sampling methods and correct

interpretation of analytical data, is useful as a diagnostic tool to assess the nutritional status of perennial plants. Its value depends upon an understanding and knowledge of changes in chemical composition of leaves with respect to age, position, time of sampling, crop, and other internal and external factors (7).

Macy (48) gives as the central concept a critical percentage of each nutrient in each kind of plant, above which there is luxury consumption and below which there is poverty adjustment range which finally reaches a minimal percentage.

Shear et al. (67) maintain that plant growth is a function of two variables of nutrition, intensity and balance. At any level of nutritional intensity, a multiplicity of ratios may exist between the elements. Maximum growth and yield occur only upon the coincidence of optimum intensity and balance.

Kenworthy (36) uses a flexible concept of nutrition, having as its starting point an area or narrow zone separating deficiency amounts from adequate amounts of each element. He proposed five ranges for each element as follows: (a) deficiency, (b) hidden hunger, (c) normal, (d) approaching excess, and (e) excess. Kenworthy (37) further indicates that fruit trees may be normal in appearance over a wide range of nutrient-element composition. The occurrence of visible symptoms of deficiency or excess is dependent upon the level of the other nutrient elements. An attempt should be made to correct first for the element or elements that are in the low or deficient range. With tree crops, that may take several years.

Factors other than nutrient supply affecting the chemical composition of leaves are age and position of leaf, cropping injury, disease and any other non-nutritional factors (7).

Peach Leaves

Kenworthy and Miller (40) compared the results of peach leaves analyzed by 16 laboratories and found good agreement for nitrogen, phosphorus, potassium, calcium, and magnesium. However, the results for manganese, boron, copper, zinc, sodium, and aluminum did not show similar agreement. The method of analysis is probably involved.

Kenworthy, cited by Childers (12), gives standard leaf composition values for all cultivars of peaches grouped together in Michigan. The values expressed as percentage of dry weight or parts per million are as follows:

1. Nitrogen - 3.87 percent
2. Phosphorus - 0.26 percent
3. Potassium - 1.68 percent
4. Calcium - 2.12 percent
5. Magnesium - 0.67 percent
6. Manganese - 151 parts per million
7. Iron - 166 parts per million
8. Copper - 18 parts per million

These values are representative of good production, vigor and fruit quality in Michigan.

The time of leaf sampling can influence the level of nutrients found in foliage because of distinct trends of several elements. Several

workers (4, 46, 63, 69) have reported that as the season progresses, the dry weight percentage of nitrogen, phosphorus, and potassium decrease while the calcium and magnesium contents tend to increase. A dilution occurs as the foliage develops because the percentage of nutrients cannot keep pace with carbohydrate synthesis. Also nutrients move continuously into the fruit during the season. For peach analysis, it is recommended that leaf samples be taken 8 to 12 weeks before bloom (11).

The level of foliar nitrogen has been shown to be influenced by several cultural practices. Some workers (9, 12, 65) indicate that the nitrogen content of leaves increases with increases in the rate of nitrogen fertilizer applications. Schneider and Correll (64) and Schneider and McClung (65) report that increases in the severity of pruning of peach trees growing in a sandy soil were related to an increase in percent nitrogen in peach leaves. Harris and Boynton (26) found that there was a tendency for foliar nitrogen to decrease in peach leaves when cover crops were used even with a high rate of nitrogen fertilization as compared to clean cultivated trees at either a low or high rate of nitrogen fertilization.

A negative relationship between nitrogen, phosphorus, and potassium in peach leaves has been reported by several investigators (28, 38, 63). Kenworthy and Gilligan (38, 39) found a positive correlation between nitrogen, phosphorus, and potassium content of leaves until a certain level was reached. Beyond this level there was a reduction in the rate of potassium absorption. Leaf analyses also showed that a high amount of phosphorus in leaves was associated with a decreased amount of

leaf nitrogen. Hitz et al. (31) found that trees grown with nitrates had leaf contents high in nitrogen and low in phosphorus and potassium.

CHAPTER III

MATERIALS AND METHODS

The study was conducted at the experimental peach orchard located on the University of Tennessee Highland Rim Experiment Station. The orchard consisted of 192 trees, set in the spring of 1962, spaced twenty feet apart in the row and between rows on a gently north-facing slope. The soil management consisted of a bluegrass - orchard grass sod on Mountview silty clay loam and Baxter cherty silty clay loam soils. The soils are naturally low in fertility.

The study was begun in the fall of 1967 and was concluded in the spring of 1970.

The experimental design was a randomized complete block. There were four blocks of 48 trees, each block containing 12 cultivars of three ripening seasons. The cultivars ripening in sequence are as follows:

Early Season

1. Hiland
2. Cardinal
3. Dixired
4. Sunhaven

Early Midseason

5. Dixigem
6. Redhaven
7. Ranger

Late Midseason

9. Washington
10. Halehaven
11. Richaven
12. Loring

I. TREATMENTS

Fertilization

Two rates of nitrogen fertilization were applied to the trees in late winter of each year. In 1967, 1.75 pounds of ammonium nitrate (NH_4NO_3) was applied as the low rate to half the trees and 2.5 pounds was applied as the high rate to half the trees. In both 1968 and 1969, the high rate was 3.5 pounds of ammonium nitrate with the low rate remaining the same. The fertilizer was applied evenly in a broad band around the dripline of each tree.

The sod was fertilized each year with 15-15-15 analysis fertilizer at the rate of 200 pounds per acre.

Pruning

Two levels of pruning severity, light and heavy, were used throughout the experiment. Half of the trees received light pruning which consisted of light to moderate heading back and thinning out to leave about 10,000 fruit buds. Half of the trees received heavy pruning which consisted of moderate to heavy heading back and thinning out to leave about 8,000 fruit buds. A model tree of each pruning level was set up each year and other trees were pruned accordingly.

Weed Control

Four weed control treatments were used each season. In 1967, and 1968, they were as follows:

1. Hand or light machine cultivation
2. Amizine (simazine plus amitrol)(4 lb./A)
3. Simazine alone (2 lb./A)
4. Paraquat (1,1'-dimethyl-4,4'-bipyridylium Dichloride) plus simazine (1 pt./A)

In 1969, 3-tert-butyl-5-chloro-6-methyluracil (terbacil)(2 lb./A) replaced the fourth treatment, paraquat plus simazine.

II. MEASUREMENTS AND RECORDINGS

Yield

Yields were recorded in both 1968 and 1969. However, the 1968 crop was almost a complete failure due to cold weather damage so it was not considered because it was felt this data would not be indicative of the different treatments. Only the full crop of 1969 was analyzed.

The number of pounds of fruit harvested per tree and the number of pounds designated as "drops" (fallen fruit) was recorded. Also, each date of harvest was recorded. The fruit was harvested by experiment station personnel who picked fruit throughout the orchard that was considered to be of firm-ripe maturity.

Growth

The trunk diameter of each tree was determined during the dormant seasons of 1967, 1968, and 1969 by measuring the circumference one foot above ground level and converting this to inches of diameter.

Pruning weights were taken of all trees in March of 1968, 1969, and 1970 before any bud activity was visible. All wood taken from the trees was recorded in pounds per tree.

III. FOLIAR ANALYSIS

Sampling

The purpose of leaf analysis was to determine if the level of any nutrient element, particularly nitrogen, was influenced by the various treatments before harvest and again after harvest.

Leaves were collected in both 1968 and 1969. In 1968, samples were collected in mid-June and again in late August from the same trees. In 1969, leaves were taken on June 23, July 7, and July 20 and again from the same trees on August 6, August 12, and August 18. The 1969 dates were selected to coincide with approximately one week before ripening of the first variety of each of the three seasons and approximately one week after the harvest of the last variety in each of the three seasons. A comparison was made between a full crop (1969) and no crop (1968).

Leaves were collected from only those trees receiving hand or light machine cultivation. On each sampling date, 20 leaves from the mid-portion of terminal shoots were selected at random from the periphery of the tree. The leaves were dried in an oven at 55 to 65°C for approximately 48 hours and then ground for analysis.

Analysis

Leaves were analyzed for nitrogen, phosphorus, potassium, calcium,

magnesium, manganese, zinc, and iron. The results for nitrogen, phosphorus, potassium, calcium, and magnesium are expressed as the percentage-of-dry-weight. The results for manganese, zinc, and iron are expressed as parts-per-million.

A 300 milligram sample of leaf tissue was digested with 3 ml. of concentrated sulfuric acid, heated at 200°C for approximately four hours, cleared with hydrogen peroxide, and made to 50 ml. for determinations.

Colorimetric determination of nitrogen was by the Nesslerization procedure (72). A 3 ml. aliquot of sulfuric acid digest was mixed with 5 ml. of sodium tartrate solution, made to 45 ml., and mixed with 5 ml. of Nessler's solution. The sample was brought to 50 ml. and after 20 minutes the absorbance at 480 mμ was determined with a Bausch and Lomb Spectronic 20.

Colorimetric determination of phosphorus was by the ammonium molybdate procedure (32). A 10 ml. aliquot of sulfuric acid digest was diluted to 35 ml. and 5 ml. of ammonium molybdate solution was added and mixed thoroughly. To this was added 2 ml. of reducing solution (1,2,4 amino napthyl sulfonic acid, sodium bisulfite, and sodium sulfite) and the solution was brought to 50 ml. After 25 minutes, the absorbance was determined at 750 mμ with a Bausch and Lomb Spectronic 20.

All other elements were determined directly with a Perkin and Elmer Atomic Absorption Spectrophotometer.

The pertinent data in all measurements and recordings were analyzed by methods as described by Snedecor (70).

CHAPTER IV

RESULTS AND DISCUSSION

I. YIELD

The mean yield and drops for each cultivar in 1969 is given in Table I. There were no differences in yield of the cultivars. There were some differences in amount of drops of each cultivar but it was noted that the yield did not seem to have any influence on drops or that the amount of drops had no influence on yields.

Table II shows that the high rate of nitrogen fertilization (3.5 pounds NH_4NO_3) increased the yield 42.79 pounds per tree over that of the low rate of nitrogen (1.75 pounds NH_4NO_3). Drops were also increased 2.55 pounds per tree with the high nitrogen rate.

There were no differences in yield or drops attributed to either the pruning treatments (Table III) or the weed control treatments (Table IV).

The twelve cultivars differed in their average first and last harvest dates and picking frequency (Table V). Some cultivars were harvested at an earlier date than others. Sunhaven and Dixigem had the longest harvest period, 15 and 14 days respectively, and as a result needed the greatest number of pickings to harvest the fruit. The picking frequency of the cultivars, however, did not correspond to the yield. This indicates that the ripening habits of cultivars are naturally different.

TABLE I

YIELD AND DROPS FOR TWELVE PEACH CULTIVARS IN 1969

Cultivar	Lbs./Tree	
	Yield	Drops
Hiland	141.47	6.45
Cardinal	139.38	4.43
Dixired	114.07	2.25
Sunhaven	117.06	6.19
Dixigem	151.01	6.99
Redhaven	108.51	2.67
Ranger	108.27	4.25
Triogem	152.82	6.12
Washington	121.37	2.55
Halehaven	140.58	6.02
Richaven	121.03	4.14
Loring	129.57	2.82
LSD .05	N.S.	2.67

TABLE II

PEACH YIELD AND DROPS DUE TO NITROGEN TREATMENTS

Nitrogen Treatment	Lbs./Tree	
	Yield	Drops
1.75 lbs. NH_4NO_3	107.36	3.35
3.50 lbs. NH_4NO_3	150.15	5.80
LSD .05	17.05	1.09

TABLE III

PEACH YIELD AND DROPS DUE TO PRUNING TREATMENTS

Pruning Treatment	Lbs./Tree	
	Yield	Drops
Light (10,000 buds)	131.20	4.99
Heavy (8,000 buds)	126.32	4.16
LSD .05	N.S.	N.S.

TABLE IV

PEACH YIELD AND DROPS DUE TO WEED CONTROL TREATMENTS

Weed Control Treatment	Lbs./Tree	
	Yield	Drops
Clean Cultivation	138.12	4.36
Amizine	130.16	4.94
Simazine	123.39	4.68
Terbacil	123.37	4.31
LSD .05	N.S.	N.S.

TABLE V

FIRST AND LAST HARVEST DATES AND PICKING FREQUENCY
FOR TWELVE PEACH CULTIVARS

Cultivar	Av. First Harvest Date	Av. Last Harvest Date	Av. Picking Frequency
Hiland	July 1	July 12	3.06
Cardinal	July 4	July 10	3.31
Dixired	July 3	July 13	3.75
Sunhaven	July 9	July 24	5.44
Dixigem	July 13	July 27	5.50
Redhaven	July 17	July 29	4.44
Ranger	July 19	July 29	3.88
Triogem	July 25	Aug. 4	4.00
Washington	July 22	Aug. 4	4.19
Halehaven	July 30	Aug. 8	3.63
Richaven	July 26	Aug. 8	4.19
Loring	July 21	Aug. 9	2.94
LSD .05	3.47	4.21	1.07

The high rate of nitrogen fertilization delayed both the average first harvest date and the average last harvest date three days as compared to the low rate (Table VI). This is similar to results reported by several workers (5, 16, 17, 26, 45, 47, 51, 52, 65). However, there was no difference in the picking frequency attributed to nitrogen treatments.

Pruning treatments (Table VII) and weed control treatments (Table VIII) did not influence either the average first or last harvest dates or the picking frequency.

There were no significant (0.05 level) interactions between yield and any of the treatments.

II. TRUNK DIAMETER

The mean trunk diameter per tree in 1967, 1968, and 1969 and the rate of increase is shown in Figure 1. There was a 0.78 inch increase in diameter in 1968 over 1967 and a 0.39 inch increase in 1969 over that of 1968. It was felt that the full crop of fruit in 1969 was responsible for the smaller increase in the mean diameter in 1969. There were also differences in the trunk diameter of the twelve cultivars (Table IX). This indicates differences in the vigor of peach cultivars.

The high rate of nitrogen fertilization increased the trunk diameter 0.52 inches per tree over that of the low rate (Table X). That nitrogen is responsible for increasing the trunk size is in agreement with other investigators (1, 16, 29).

There was no difference in trunk diameter attributed to pruning

TABLE VI

FIRST AND LAST HARVEST DATES AND PICKING FREQUENCY DUE TO NITROGEN TREATMENTS

Nitrogen Treatment	Average Harvest Date[a]		Picking Frequency
	First	Last	
1.75 lbs. NH_4NO_3	July 15	July 26	3.98
3.50 lbs. NH_4NO_3	July 18	July 29	4.07
LSD in Days .05	1.41	1.72	N.S.

[a]Reference dates are the beginning of harvest on June 30 and the ending of harvest on August 12.

TABLE VII

FIRST AND LAST HARVEST DATES AND PICKING FREQUENCY
DUE TO PRUNING TREATMENTS

Pruning Treatment	Average Harvest Date[a]		Picking Frequency
	First	Last	
Light (10,000 buds)	July 16	July 27	4.12
Heavy (8,000 buds)	July 17	July 27	3.94
LSD in Days .05	N.S.	N.S.	N.S.

[a]Reference dates are the beginning of harvest on June 30 and the ending of harvest on August 12.

TABLE VIII

FIRST AND LAST HARVEST DATES AND PICKING FREQUENCY
DUE TO WEED CONTROL TREATMENTS

Weed Control Treatment	Average Harvest Date[a]		Picking Frequency
	First	Last	
Clean Cultivation	July 15	July 27	4.46
Amizine	July 16	July 27	3.98
Simazine	July 17	July 29	4.13
Terbacil	July 18	July 28	3.54
LSD in Days .05	N.S.	N.S.	N.S.

[a]Reference dates are the beginning of harvest on June 30 and the ending of harvest on August 12.

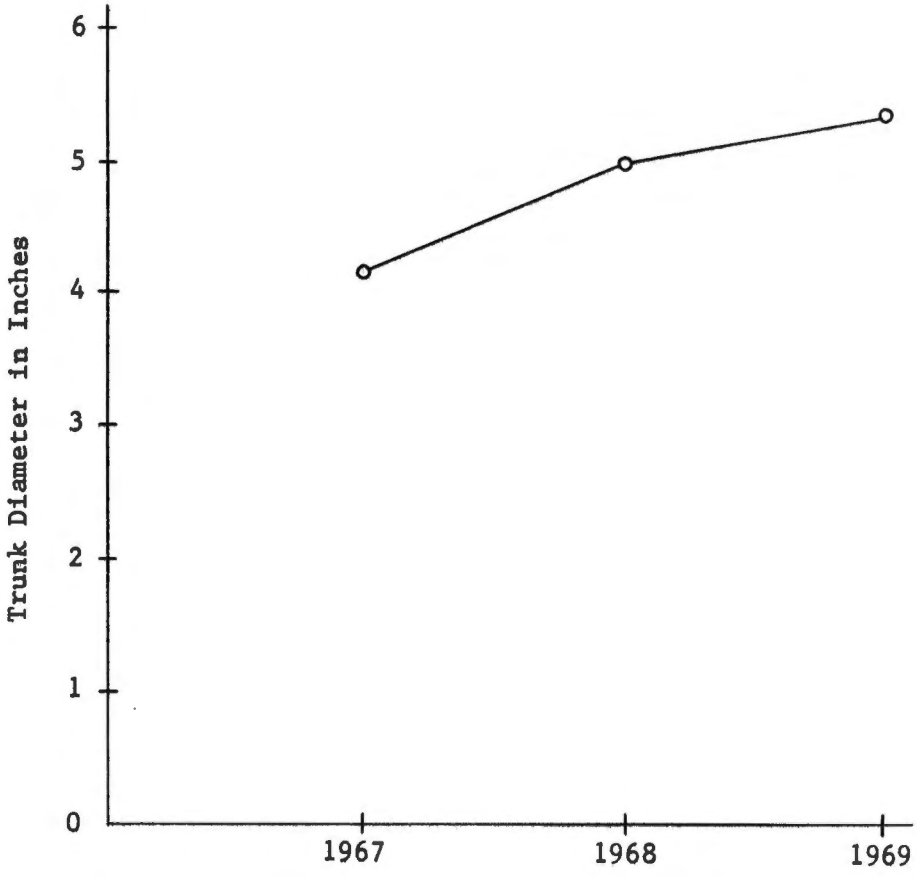

Figure 1. Mean trunk diameter per tree in 1967, 1968, and 1969.

TABLE IX

TRUNK DIAMETER FOR TWELVE PEACH CULTIVARS, 1967 - 1969

Variety	Trunk Diameter in Inches
Hiland	5.27
Cardinal	4.64
Dixired	4.50
Sunhaven	4.47
Dixigem	5.16
Redhaven	4.54
Ranger	4.61
Triogem	5.24
Washington	5.33
Halehaven	5.20
Richaven	4.41
Loring	4.58
LSD .05	.35

TABLE X

TRUNK DIAMETER DUE TO NITROGEN TREATMENTS

Nitrogen Treatment[a]	Trunk Diameter in Inches
1.75 lbs. NH_4NO_3	4.57
3.50 lbs. NH_4NO_3	5.09
LSD .05	.13

[a]The high rate of nitrogen in 1967 was 2.5 lbs.

treatments (Table XI) but there was a nitrogen and pruning interaction (Table XII). Schneider and McClung (65) and Schneider et al. (66) have reported that nitrogen and pruning tend to interact. At the low rate of nitrogen, light pruned trees had a greater mean trunk diameter whereas at the high rate of nitrogen fertilization the heavy pruned trees had the greatest mean diameter. It was felt that the heavy pruned trees at the low nitrogen rate did not recover from the removal of more wood and as a result did not make as much leaf area as the light pruned trees. The heavy pruned trees were more stimulated and made more leaf area than light pruned trees at the high nitrogen rate.

Table XIII indicates that there were some differences in trunk diameter due to weed control treatments. The largest diameter occured with the hand or clean cultivated treatment. It was believed that this was due to better moisture retention, aeration, and possibly a greater rate of nitrification in the soil.

There was a difference in the trunk diameter of trees in the four blocks (Table XIV). Block three had a greater diameter per tree than the other blocks and this can be attributed to the slope and the soil of the orchard. In block three, the soil is deeper and probably more retentive of moisture and the slope is less than that of the other blocks.

III. PRUNING WEIGHTS

The mean pruning weight per tree in 1968, 1969, and 1970 is shown in Figure 2. There was a 6.91 pound increase per tree in 1969 over 1968

TABLE XI

TRUNK DIAMETER DUE TO PRUNING TREATMENTS

Pruning Treatment	Trunk Diameter in Inches
Light (10,000 buds)	4.88
Heavy (8,000 buds)	4.78
LSD .05	N.S.

TABLE XII

TRUNK DIAMETER DUE TO NITROGEN X PRUNING INTERACTION

Pruning Treatment	Diameter in Inches		
	1.75 Lbs. N	3.50 Lbs. N	Mean
Light (10,000 buds)	4.80	4.96	4.88
Heavy (8,000 buds)	4.35	5.21	4.78
Nitrogen Mean	4.57	5.09	-
Nitrogen X Pruning LSD .05		.19	

[a]The high rate of nitrogen in 1967 was 2.5 lbs.

TABLE XIII

TRUCK DIAMETER DUE TO WEED CONTROL TREATMENTS

Weed Control Treatment[a]	Trunk Diameter in Inches
Clean Cultivation	4.98
Amizine	4.69
Simazine	4.87
Terbacil	4.78
LSD .05	.19

[a]In 1969, Terbacil replaced the treatment Paraquat plus Simazine.

TABLE XIV

DIAMETER OF PEACH TREE TRUNKS IN VARIOUS BLOCKS

Block	Trunk Diameter in Inches
1	4.87
2	4.41
3	5.27
4	4.77
LSD .05	.19



Figure 2. Mean pruning weight per tree in 1968, 1969, and 1970.

and a 0.69 pound increase per tree in 1970 over 1969. It was felt that the differences of virtually no fruit crop in 1968 and a full crop in 1969 was responsible for the great increase of pruning wood in 1969 and the smaller increase in 1970. The full crop reduced terminal shoot growth. There were differences in the amount of pruning wood taken from the twelve cultivars (Table XV). This further indicates differences in the vigor of peach cultivars.

The high rate of nitrogen fertilization increased the pruning wood 8.93 pounds per tree over that of the low rate (Table XVI). Nitrogen was responsible for greatly increasing terminal shoot growth.

There was a nitrogen and pruning interaction (Table XVII) with more wood removed from the light pruned trees at the low nitrogen rate whereas more wood was removed from the heavy pruned trees at the high rate of nitrogen. This interaction corresponds to the same interaction involving trunk diameter which indicates that the size of the trunk is closely related to the amount of terminal shoot growth.

A nitrogen and years interaction (Table XVIII) shows a steady increase in the amount of wood removed from low nitrogen fertilization trees in 1968, 1969, and 1970 and a greater increase in pruning wood for the high nitrogen rate in 1969 over that of 1968. In 1970, there was a slight decrease in pruning wood per tree from 1969 at the high nitrogen rate. Apparently at the low nitrogen fertilization rate there was not a large enough fruit crop to hinder growth but the trees did not make as much growth as those fertilized at the high nitrogen rate. The fruit crop reduced terminal growth at the high nitrogen rate in 1969. A pruning and years interaction (Table XIX) has a similar trend.

TABLE XV

PRUNING WEIGHTS FOR TWELVE PEACH CULTIVARS, 1968 - 1970

Cultivar	Pruning Weight Lbs./Tree
Hiland	23.60
Cardinal	19.14
Dixired	17.07
Sunhaven	17.08
Dixigem	19.79
Redhaven	19.21
Ranger	15.18
Triogem	19.49
Washington	17.47
Halehaven	20.47
Richaven	17.95
Loring	16.24
LSD .05	3.42

TABLE XVI

PRUNING WEIGHT DUE TO NITROGEN TREATMENTS

Nitrogen Treatment[a]	Pruning Weight Lbs./Tree
1.75 lbs. NH_4NO_3	14.09
3.50 lbs. NH_4NO_3	23.02
LSD .05	1.16

[a]The high rate of nitrogen in 1967 was 2.5 lbs.

TABLE XVII

PRUNING WEIGHT DUE TO NITROGEN X PRUNING INTERACTION

Pruning Treatment	Weight in Lbs./Tree[a]		
	1.75 Lbs. N	3.50 Lbs. N	Mean
Light (10,000 buds)	14.82	21.64	18.23
Heavy (8,000 buds)	13.37	24.40	18.88
Nitrogen Mean	14.09	23.02	-
Nitrogen X Pruning LSD .05		1.64	

[a]The high rate of nitrogen in 1967 was 2.5 lbs.

TABLE XVIII

PRUNING WEIGHT DUE TO NITROGEN X YEARS INTERACTION

Nitrogen Treatment[a]	Weight in Lbs./Tree			
	1968	1969	1970	Mean
1.75 lbs. NH_4NO_3	12.09	13.79	16.40	14.09
3.50 lbs. NH_4NO_3	15.37	27.46	26.23	23.02
Years Mean	13.73	20.63	21.32	-
Nitrogen X Years LSD .05		1.16		

[a]The high rate of nitrogen in 1967 was 2.5 lbs.

TABLE XIX

PRUNING WEIGHT DUE TO PRUNING X YEARS INTERACTION

Pruning Treatment	Weight in Lbs./Tree			
	1968	1969	1970	Mean
Light (10,000 buds)	12.54	20.18	21.97	18.23
Heavy (8,000 buds)	14.91	21.07	20.67	18.88
Years Mean	13.73	20.63	21.32	-
Pruning X Years LSD .05		2.01		

There were no differences in pruning weights attributed to pruning treatments (Table XX) and weed control treatments (Table XXI).

A difference in the amount of wood removed per tree among the four blocks (Table XXII) can be attributed to the soil and the slope of the orchard. Similar to results reported for the trunk diameter, block three had the largest pruning weights per tree.

IV. FOLIAR ANALYSIS

The dry weight percentage of N, P, K, Ca, and Mg and parts per million of Mn, Zn, and Fe in 1968 and 1969 are given in Table XXIII. There was an increase of N, Mg, Mn, Zn, and Fe in 1969 over 1968. The elements P and K were lower in 1969 while Ca did not differ in either year of sampling. A crop load apparently affects the uptake of nutrients as evidenced by McClung and Lott (46) who reported that Ca and Mg contents were a bit lower and K content was a bit higher in leaf samples of trees without a crop load. The full crop of fruit in 1969 apparently increased the level of several nutrients in the leaves and decreased the level of P and K because of the demand by the fruit for these nutrients.

The rate of nitrogen fertilization can influence the level of nutrients in leaves (Table XXIV). At the high rate, there was an increase in N, Mn, and Fe and a decrease in P and Mg. There was no difference in the level of the other elements. Ritter (63) had reported that leaf N and Mn were increased by large additions of nitrogen to the soil. There was probably a dilution of the amount of P and Mn in the

TABLE XX

PRUNING WEIGHT DUE TO PRUNING TREATMENTS

Pruning Treatment	Pruning Weight Lbs./Tree
Light (10,000 buds)	18.23
Heavy (8,000 buds)	18.88
LSD .05	N.S.

TABLE XXI

PRUNING WEIGHT DUE TO WEED CONTROL TREATMENTS

Weed Control Treatment[a]	Pruning Weight Lbs./Tree
Clean Cultivation	18.95
Amizine	17.97
Simazine	18.86
Terbacil	18.45
LSD .05	N.S.

[a]In 1969, Terbacil replaced the treatment Paraquat plus Simazine.

TABLE XXII

PRUNING WEIGHT PER TREE IN THE VARIOUS BLOCKS

Block	Pruning Weight Lbs./Tree
1	19.12
2	16.57
3	21.28
4	17.25
LSD .05	1.64

TABLE XXIII

NUTRIENT ELEMENTS IN LEAVES IN 1968 AND 1969 WITH SAMPLING DATES AND TREATMENTS COMBINED

	Dry Weight							
	Percent					Ppm		
Year	N	P	K	Ca	Mg	Mn	Zn	Fe
1968	2.00	.14	1.95	2.64	.43	68	81	112
1969	2.12	.13	1.70	2.55	.53	98	105	141
LSD .05	.09	.008	.11	N.S.	.02	8	7	9

TABLE XXIV

NUTRIENT ELEMENTS IN LEAVES DUE TO NITROGEN TREATMENTS WITH SAMPLING DATES AND YEARS COMBINED

	Dry Weight							
	Percent					Ppm		
Nitrogen Treatment	N	P	K	Ca	Mg	Mn	Zn	Fe
1.75 lbs. NH_4NO_3	1.90	.14	1.83	2.63	.50	71	93	122
3.50 lbs. NH_4NO_3	2.21	.13	1.83	2.56	.45	95	92	131
LSD .05	.09	.008	N.S.	N.S.	.02	8	7	9

leaves since the high rate of nitrogen probably increased the size and weight of the leaves. That the nitrogen content of leaves increases with increases in the rate of nitrogen fertilization has been reported by several workers (9, 12, 65).

Table XXV indicates that there was a decrease in N and Zn and an increase in Ca and Mg as the season progressed. Although there was no change in P and K, these results are similar for the elements N, Ca, and Mg to that reported by several workers (4, 46, 63, 69). The after harvest percentage of N is considered to be low. This indicates that both a fruit crop and growth process exert a heavy demand on nitrogen as the season progresses.

There was a time and years interaction for N, P, Mg, Mn, and Fe (Table XXVI). There tended to be a greater decrease for N and a greater increase for Mg when comparing before and after harvest sample dates in 1968 than in 1969. Both Mn and Fe contents increased as the season progressed in 1968 and decreased as the season progressed in 1969. P decreased as the season progressed in 1968 and increased as the season progressed in 1969. It was felt that the peach tree will take up nutrients in different quantities depending on whether there is a crop present or not. In 1968 there tended to be a greater difference in the level of N and Mg than 1969 which indicates that growth processes may influence nutrient levels more than the presence of a fruit crop. The moisture supply is also involved.

There was no difference in the level of nutrients attributed to the pruning treatments (Table XXVII).

TABLE XXV

NUTRIENT ELEMENTS IN LEAVES DUE TO TIME OF SAMPLING WITH TREATMENTS AND YEARS COMBINED

	Dry Weight							
	Percent					Ppm		
Time of Sampling	N	P	K	Ca	Mg	Mn	Zn	Fe
Before Harvest	2.15	.14	1.82	2.48	.44	84	102	128
After Harvest	1.96	.14	1.84	2.71	.51	82	84	125
LSD .05	.09	N.S.	N.S.	N.S.	.02	N.S.	7	N.S.

TABLE XXVI

NUTRIENT ELEMENTS IN LEAVES DUE TO TIME X YEARS INTERACTION

Year and Time of Sampling	Dry Weight							
	Percent					Ppm		
	N	P	K	Ca	Mg	Mn	Zn	Fe
1968								
Before Harvest	2.16	.15	1.90	2.52	.37	63	89	109
After Harvest	1.83	.14	2.00	2.76	.49	73	72	115
1969								
Before Harvest	2.14	.13	1.74	2.43	.51	105	114	148
After Harvest	2.09	.14	1.67	2.66	.52	90	96	134
LSD .05	.12	.01	N.S.	N.S.	.03	11	N.S.	13

TABLE XXVII

NUTRIENT ELEMENTS IN LEAVES DUE TO PRUNING TREATMENTS
WITH SAMPLING DATES AND YEARS COMBINED

	Dry Weight							
	Percent					Ppm		
Pruning Treatment	N	P	K	Ca	Mg	Mn	Zn	Fe
Light (10,000 buds)	2.01	.14	1.82	2.61	.48	80	93	125
Heavy (8,000 buds)	2.10	.14	1.83	2.57	.47	85	93	128
LSD .05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

In general, the mean percentage of N and P in leaves at the time they were sampled in both 1968 and 1969 were considerably lower than that reported by Kenworthy as cited by Childers (12). However, all other elements tended to be in fair agreement. It was felt that several factors could be responsible for differences such as the area from which the samples come from, the time of sampling, and the methods of analysis used.

CHAPTER V

SUMMARY

The study of the vigor and production of twelve peach (Prunus persica) cultivars was carried out from the fall of 1967 to spring of 1970 on the University of Tennessee Highland Rim Experiment Station, Springfield, Tennessee. The study was initiated to determine how peaches respond to two levels of nitrogen fertilization, two levels of pruning, and four weed control treatments with respect to yields and growth of the tree.

The number of pounds of fruit harvested per tree was recorded in 1969. The trunk diameter in inches was recorded in 1967, 1968, and 1969 and pruning weights were recorded in pounds in 1968, 1969, and 1970. Leaf samples were taken for analysis of nutrient elements in 1968 and 1969 at two periods, before harvest and after harvest.

There were no differences in the yield of the twelve cultivars and nitrogen fertilization was the only treatment that influenced yields. The high rate of nitrogen greatly increased yields and delayed maturity three days.

There were differences in both the mean trunk diameter and pruning weight of the twelve cultivars. A greater trunk diameter was not related to a greater yield. Nitrogen influenced both the mean trunk diameter and pruning weight and the weed control treatments influenced the trunk diameter but not the pruning weights. Trees in the hand cultivated treatment had the greatest trunk diameter with simazine

treated ones having the largest diameter in the herbicide treated plots. Pruning did not influence either the trunk diameter or pruning weights. However, pruning and nitrogen were found to interact with respect to the trunk diameter and pruning weights.

Foliar analysis showed that the level of nitrogen in the leaves was low and that growth processes may cause a greater difference in the level of nutrients in leaves than the presence of a crop of fruit.

In general, indications are that for best production and growth of peach trees nitrogen should be used in liberal amounts along with light to moderate pruning.

LITERATURE CITED

LITERATURE CITED

1. Armstrong, W. D., H. P. Stuckey, and H. L. Cochran. 1935. Nitrogen Fertilizer Studies with the Elberta Peach. Proc. Amer. Soc. Hort. Sci. 33:268.

2. Ashley, T. E. 1931. Some Vegetative Responses of the Peach to Applications of Nitrate of Soda. Proc. Amer. Soc. Hort. Sci. 28:28-31.

3. Ballinger, W. E., A. H. Hunter, F. E. Correll, and G. A. Cummings. 1962. Interrelationships of Irrigation, Nitrogen Fertilization and Pruning of Redhaven and Elberta Peaches in the Sandhills of North Carolina. Proc. Amer. Soc. Hort. Sci. 83:248-258.

4. Batjer, L. P., and M. M. Westwood. 1958. Seasonal Trend of Several Nutrient Elements in Leaves and Fruits of Elberta Peach. Proc. Amer. Soc. Hort. Sci. 71:116-126.

5. Blake, M. A. 1921. Effect of an Early Application of Nitrogen on Peach Trees Deficient in Vigor. Proc. Amer. Soc. Hort. Sci. 18:139-143.

6. _____. 1921. Some Results of Pruning Investigations with Peaches. Proc. Amer. Soc. Hort. Sci. 18:213-222.

7. Bould, C., F. G. Bradford, and G. M. Clarke. 1960. Leaf Analysis as a Guide to the Nutrition of Fruit Crops I: General Principles, Sampling Techniques, and Analytical Methods. Jour. Sci. Food and Agr. 11:229-242.

8. Brown, D. S. 1945. The Growth and Composition of the Tops of Peach Trees in Sand Cultures in Relation to Nutrient-Element Balance. W. Va. Agr. Exp. Sta. Bul. 322, 72 pp.

9. Brown, L. C., and E. L. Proebsting. 1962. Nitrogen and Crop Effects on Canned Freestone Peach Quality. Calif. Agr. 16(1):7.

10. Cain, J. C., and R. J. Mehlenbacher. 1956. Effects of Nitrogen and Pruning on Trunk Growth in Peaches. Proc. Amer. Soc. Hort. Sci. 67:139-143.

11. Chapman, H. D. 1964. Foliar Sampling for Determining the Nutrient Status of Crops. World Crops. Sept., pp 36-46.

12. Childers, N. F. 1966. Fruit Nutrition. 2nd ed. Horticultural Publications, New Brunswick, New Jersey.

13. Cooper, J. R. 1925. Some Factors Influencing the Production of Peaches in the South. Proc. Amer. Soc. Hort. Sci. 22:237-245.

14. _____. 1940. Fertilizer for Peach Trees. Ark. Exp. Sta. An. Rpt. Bul. 405, pp 25-26.

15. _____. 1943. Effect of Commercial Fertilizers on Performance of Peach Trees. Ark. Agr. Exp. Sta. Bul. 429, 46 pp.

16. Cowart, F. F., and E. F. Savage. 1947. The Effect of Nitrogen Fertilization on Yield and Growth of Elberta Peach Trees. Ga. Agr. Exp. Sta. Bul. 253, 16 pp.

17. Crane, H. L. 1924. Experiments in Fertilizing Peaches. W. Va. Agr. Exp. Sta. Bul. 183, 72 pp.

18. Cullinan, F. P. 1931. Some Relationships Between Tree Response and Internal Composition of Shoots of The Peach. Proc. Amer. Soc. Hort. Sci. 28:1-5.

19. Degman, E. S. 1930. Firmness and Keeping Quality of Fruits as Affected by Nitrogen Fertilizers. Proc. Amer. Soc. Hort. Sci. 26:182-186.

20. _____. 1934. Studies on Firmness and Keeping Quality of Certain Fruits. I: Effects of Nitrogen Fertilization. Md. Agr. Exp. Sta. Bul. 366, pp 1-68.

21. Ford, H. W., and W. P. Judkins. 1951. The Effect of Cultural and Nitrogen Treatments on the Rate of Respiration and Certain Indices of Maturity of Halehaven Peaches. Proc. Amer. Soc. Hort. Sci. 57:73-80.

22. Gilbert, F., L. Holm, and L. Rake. 1965. The Growth of Red Tart Cherry Trees with Annual Applications of Simazine and Diuron. Weeds 13:11-12.

23. Goren, R., and S. P. Monselise. 1966. Some Physiological Effects of Triazines on Citrus Trees. Weeds 14:141-144.

24. Green, F. M., and A. M. Brinkley. 1958. A Guide to Growing Fruit in Colorado. Colo. Agr. Exp. Sta. Bul. 447-A.

25. Harman, F. N. 1933. Relation of Pruning and Thinning to Fruit Size and Yield of Paloro Peaches. Proc. Amer. Soc. Hort. Sci. 80:177-189.

26. Harris, R. W., and D. Boynton. 1952. Nitrogen Fertilization and Cultural Practices in Relation to Growth and Fruitfulness of an Elberta Peach Orchard in New York. Proc. Amer. Soc. Hort. Sci. 59:36-52.

27. Havis, L., and J. H. Gourley. 1937. Peach Production in Ohio. Ohio Agr. Exp. Sta. Bul. 581, 41 pp.

28. _____, and A. L. Gilkeson. 1951. Interrelationships of Nitrogen and Potassium Fertilization and Pruning Practice in Mature Peach Trees. Proc. Amer. Soc. Hort. Sci. 57:24-30.

29. Higgins, B. B., C. P. Walton, and J. J. Skinner. 1943. The Effect of Nitrogen Fertilization on Cold Injury of Peach Trees. Ga. Agr. Exp. Sta. Bul. 226, 27 pp.

30. Hill, R. G. Jr. 1962. The Effect of Sod as a Soil Management Practice Upon the Growth and Yield of the Peach. Ohio Agr. Exp. Sta. Res. Bul. 903, 35 pp.

31. Hitz, C. W., G. M. Gilligan, and H. Amling. 1956. Effect of Soil Management Upon Soil and Leaf Analysis in a Peach Orchard. Del. Agr. Exp. Sta. Bul. 316, 20 pp.

32. Jackson, M. L. 1953. Soil Chemical Analysis. Prentice-Hall, Inc., Englewood Cliffs, N. J.

33. Johnston, S., and R. P. Larsen, 1965. Peach Culture in Michigan. Mich. Agr. Ext. Bul. 509, 21 pp.

34. Judkins, W. P. 1949. The Relationship of Leaf Color, Nitrogen, and Rainfall to the Growth of Young Peach Trees. Proc. Amer. Soc. Hort. Sci. 53:29-36.

35. _____, and I. W. Wander. 1950. Correlation Between Leaf Color, Leaf Nitrogen Content, and Growth of Apple, Peach, and Grape Plants. Plant Physiol. 25:78-85.

36. Kenworthy, A. L. 1949. Wheels of Nutrition - A Concept for Determining Nutrient-Element Deficiencies. Proc. Amer. Soc. Hort. Sci. 54:47-52.

37. _____. 1950. Nutrient-Element Composition of Leaves from Fruit Trees. Proc. Amer. Soc. Hort. Sci. 55:41-46.

38. _____, and G. M. Gilligan. 1947. Influence of Soil Management Practices on Tree Growth and Leaf and Soil Analysis in a Young Peach Orchard. Del. Agr. Exp. Sta. Cir. 21, 10 pp.

39. _____, and _____. 1948. Interrelationships Between the Nutrient Content of Soil, Leaves, and Trunk Circumference of Peach Trees. Proc. Amer. Soc. Hort. Sci. 51:209-215.

40. _____, and E. J. Miller. 1965. Nutrient-Element Analysis of Fruit Tree Leaf Samples by Several Laboratories. Proc. Amer. Soc. Hort. Sci. 67:16-21.

41. Lagasse, F. S. 1929. Some Growth Responses of Elberta Peach Trees to Fertilizer Treatments. Proc. Amer. Soc. Hort. Sci. 26:187-190.

42. Larsen, R. P., and S. K. Ries. 1960. Simazine for Controlling Weeds in Fruit Tree and Grape Plantings. Weeds 8:671-677.

43. Lord, W. J., E. F. Vlach, and R. A. Damon, Jr. 1967. Response of Jerseyland Peach Trees to Three Consecutive Yearly Herbicide Applications of Simazine and Dalapon Alone and in Combination. Hortscience 2(4):146-148.

44. Lott, R. V. 1931. Some Fruiting Response of the Peach to Applications of Nitrate of Soda. Proc. Amer. Soc. Hort. Sci. 28:23-27.

45. _____. 1942. Effect of Nitrate of Soda on Development of the Halehaven Peach. Ill. Agr. Exp. Sta. Bul. 493, 62 pp.

46. McClung, A. C., and W. L. Lott. 1956. Mineral Nutrient Composition of Peach Leaves as Affected by Leaf Age and Position and the Presence of a Fruit Crop. Proc. Amer. Soc. Hort. Sci. 67:113-120.

47. McCue, C. A. 1914. A Fertilizer Experiment with Peaches. Proc. Amer. Soc. Hort. Sci. 11:86-91.

48. Macy, P. 1936. Quantitative Mineral Nutrient Requirements of Plants. Plant Physiol. 11:749-763.

49. Marshall, R. E. 1931. The Fruiting Habit of the Peach as Influenced by Pruning Practices. Mich. Agr. Exp. Sta. Tech. Bul. 116, 58 pp.

50. Morris, J. R., A. A. Kattan, and E. M. Arrington. 1962. Response of Elberta Peaches to the Interactive Effects of Irrigation, Pruning, and Thinning. Proc. Amer. Soc. Hort. Sci. 80:177-189.

51. Mowry, J. B. 1963. A Way to Get Big Peaches. Amer. Fruit Grower 83(3):14, 56-57, 59.

52. Nightingale, G. T., R. M. Addoms, and M. A. Blake. 1930. Development and Ripening of Peaches as Correlated with Physical Characteristics, Chemical Composition, and Histological Structure of the Fruit Flesh: III Macrochemistry. N. J. Agr. Exp. Sta. Bul. 494, 16 pp.

53. Overcash, J. P., J. A. Campbell, and S. P. Crockett. 1951. Progress Report on Peach Fertilizer Studies. Miss. Farm Res. 14(2):8.

54. _____, _____, and _____. 1960. Peach Fertilizer and Pruning Experiments. Miss. Agr. Exp. Sta. Bul. 596, 23 pp.

55. Pickett, B. S. 1920. Response of a Young Peach Orchard to Certain Cover Crops and Fertilizer Treatments. Proc. Amer. Soc. Hort. Sci. 17:193-197.

56. _____. 1921. The Effects of Certain Soil Treatments on the Formation of Fruit Buds in Peaches. Proc. Amer. Soc. Hort. Sci. 18:80-82.

57. Proebsting, E. L. 1937. Fertilizing Deciduous Fruit Trees in California. Calif. Agr. Sta. Bul. 610, 29 pp.

58. _____. 1958. Yield, Growth, and Date of Maturity of Elberta Peaches as Influenced by Soil Management Systems. Proc. Amer. Soc. Hort. Sci. 72:193-197.

59. _____, and C. F. Kinman. 1933. Orchard Trials of Nitrogen and Phosphorus. Proc. Amer. Soc. Hort. Sci. 30:426-430.

60. _____, G. H. Carter, D. W. Ingalsbe, and A. M. Neubert. 1957. Relationship Between Leaf Nitrogen and Canning Quality of Elberta Peaches. Proc. Amer. Soc. Hort. Sci. 69:131-140.

61. Reeve, R. M., and C. H. H. Neufeld. 1959. Histology and Texture of Elberta Peaches from Trees of High and Low Levels of Nitrogen Nutrition. Food. Res. 24:552-563.

62. Ries, S. K., R. P. Larsen, and A. L. Kenworthy. 1963. The Apparent Influence of Simazine on Nitrogen Nutrition of Peach and Apple Trees. Weeds 11(4):270-273.

63. Ritter, C. M. 1956. Effects of Varying Rates of Nitrogen Fertilization on Young Elberta Peach Trees. Proc. Amer. Soc. Hort. Sci. 68:48-55.

64. Schneider, G. W., and F. E. Correll. 1956. Peach Pruning Studies in the North Carolina Sandhills. Proc. Amer. Soc. Hort. Sci. 67:144-152.

65. _____, and A. C. McClung. 1957. Interrelationships of Pruning, Nitrogen Rate, and Time of Nitrogen Applications in Halehaven Peach. Proc. Amer. Soc. Hort. Sci. 68:141-147.

66. _____, I. D. Jones, and A. C. McClung. 1958. Studies of Pruning Effects, and of Rate and Time of Nitrogen Fertilization on Certain Chemical and Physical Characteristics of Peach Fruit. Proc. Amer. Soc. Hort. Sci. 71:110-115.

67. Shear, C. B., H. L. Crane, and A. T. Myers. 1946. Nutrient-Element Balance: A Fundamental Concept in Plant Nutrition. Proc. Amer. Soc. Hort. Sci. 47:239-248.

68. Smith, F. W. 1956. Fertilizer Recommendations. Kansas Agr. Exp. Sta. Cir. 285:19.

69. _____, C. B., and G. A. Taylor. 1952. Tentative Optimum Leaf Concentration of Several Elements for Elberta Peach and Stayman Apple in Pennsylvania Orchards. Proc. Amer. Soc. Hort. Sci. 60:34-41.

70. Snedecor, G. W. 1946. Statistical Methods. 4th ed. The Iowa State College Press, Ames, Iowa.

71. Stembridge, G. E., C. E. Gambrell, H. J. Sefick, and L. O. Van Bloricom. 1962. The Effect of High Rates of Nitrogen and Potassium on the Yield, Quality, and Foliar Mineral Composition of Dixigem Peaches in the South Carolina Sandhills. Proc. Amer. Soc. Hort. Sci. 81:153-161.

72. Thompson, J. F., and G. R. Morrison. 1951. Determination of Organic Nitrogen - Control of the Variable in the Use of Nessler's Reagent. Anal. Chem. 23:1153-1157.

73. Westwood, W. N., and R. K. Gerber. 1958. Seasonal Light Intensity and Fruit Quality Factors as Related to the Method of Pruning Peach Trees. Proc. Amer. Soc. Hort. Sci. 72:85-91.

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