NORTH CAROLINA STATE COLLEGE
SCHOOL OF AGRICULTURE
RALEIGH, N. C.

March 17, 1958

Department of Horticulture

Dr. F. D. Cochran, Head
Department of Horticulture
Campus

Dear Dr. Cochran:

Attached is my 1957 annual report. Since the report is for departmental use I have not spent as much time in preparing the report as I would if it were to be published. Most of the material was typed only once.

This being the first report there was a question of how detailed and complete it should be. In order to prepare the 1958 report in a better manner, I would appreciate your comments and suggestions on this report.

Sincerely yours,

Dave

David R. Walker
Assistant Professor

DRW/jg

Attachment

1957 ANNUAL REPORT

By

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North Carolina State College

March 14, 1958

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a. Donoho, C. W. and D. R. Walker. 1957. The effect of gibberellic acid on the breaking of the rest period in the Elberta peach. Science 126:1178-1179.

b. Walker, D. R. 1958. Apples need boron. Research and Farming. 16:(3)4.

c. Walker, D. R., C. H. Hendershott and G. W. Snedecor. 1958. A statistical evaluation of a growth substance bioassay method using extracts of dormant peach buds. Plant Physiology. (In Press).

d. Walker, D. R. and E. G. Fisher. 1957. The Use of Chelated Magnesium and Magnesium Sulfate in Correcting Magnesium Deficiency in Apple Orchards. Proc. Amer. Soc. Hort. Sci. Volume 70:15-20.

e. Walker, D. R. Notes on the fertilization of apple orchards in North Carolina. Mimeograph distributed at N. C. apple growers annual meeting and fruit schools.

f. Fisher, E. G., D. R. Walker, D. Boynton and S. S. Kwong. 1958. Magnesium deficiency studies on apple trees. Treatments for control and tree response. Submitted for publication in Proc. Amer. Soc. Hort. Sci. (Copy of manuscript not available).

g. Schneider, G. W., D. R. Walker and F. E. Correll. 1958. A controlled temperature chamber for hardiness studies with young fruit trees. Submitted for publication in Proc. Amer. Soc. Hort. Sci. (Copy of manuscript not available).

2. Copy of leaf and soil analyses collected for nutrient-element survey.

A Study of Winter Hardiness in Peach Trees:

Peach trees spend much of their lifetime coming into production and in decline, with only a few years of good production. The broad term "winter injury" has been listed as the cause of death for lack of knowledge of the real cause. Peaches are grown commercially much farther north where temperatures are lower during the winter, yet peach trees in North Carolina may experience as much or more damage.

In order to learn more about hardiness of peach trees, an investigation of the effect various temperature treatments had on peach hardiness was undertaken. Hardiness of the trees was measured as electrical conductance, which many investigators have found correlates closely with injury of the trees. Cold damage ruptures the cells which releases salts and other constituents in solution; increasing the electrical conductivity of the solution. The results of the 1956-57 and 1957-58 seasons determinations are presented; although the statistical analysis has not been completed.

Materials and Methods

One year old Elberta peach trees were grown in sterilized soil during 1956 and 1957 in large cans outdoors. Sawdust was placed around the cans to prevent high root temperatures during the summer. The trees were fertilized and watered during the growing season and were used in the hardiness tests after the leaves had fallen off in the fall. In the fall the trees were transferred to cold storage rooms. One of the rooms was maintained at 40°F. and the other at 65°F. Lights were on in the rooms each day between 8 a.m. and 5 p.m. and the trees were watered as needed. The trees were used for a number of experiments which are described below. After the trees had received a cold treatment they were placed in the controlled temperature chamber, which was adjusted to reduce the temperature gradually (3° per hour) from room temperature to 0° F. The trees remained in the 0°F. temperature chamber for 12 hours. After the trees had received this cold treatment the temperature was gradually raised to room temperature before they were removed from the chamber.

Upon removing the trees from the chamber samples of twigs were collected from each tree and placed in distilled water for 24 hours. After this time period the electrical conductivity of the solution was measured. Each twig sample consisted of five terminal twigs each five inches long. The twigs selected for the samples were weighed, washed, dried and cut into one inch pieces. The twenty-five one inch pieces were placed with five times as much water as the twigs weighed, for the twenty four hour incubation period.

After the twig samples were collected the trees were placed in the 40°F. cold storage room until they had received sufficient cold to "break" the rest period. They were then placed in the greenhouse and tree survival data were recorded after allowing sufficient time for the trees to leaf out if they were alive.

The following treatments have been studied using the above methods:

1956-1957

Experiment I.

1. Continuous 65°F.
2. Continuous 40°F.
3. Continuous 40°F. then temperature raised to 65°F. for 1 day
4. Continuous 40°F. then temperature raised to 65°F. for 5 days
5. Continuous 40°F. then temperature lowered to 32°F. for 1 day
6. Continuous 40°F. then temperature lowered to 32°F. for 5 days

These were two trees per treatment and the test was made at four different times during the dormant season.

Experiment II.

Trees subjected to both continuous 40°F and 65°F. were placed at 0, 7, 14 and 21°F. temperature treatments at three times during the dormancy period. Two trees were used for each treatment. Conductivity and survival data were recorded for each tree. Additional information concerning the measurement of conductivity was also studied with trees in this experiment. The following items were studied in this connection:

a. The effect of the number of pieces of one inch twigs on conductivity.
b. The effect of time the twigs are left in the distilled water on conductivity.
c. The effect of size of twigs on conductivity.
d. The effect of twig location on tree in relation to conductivity.

Experiment III. The effect of intermittent warm and cold period on peach hardiness.

1. Trees subjected to continuous 40°F.
2. Trees subjected to continuous 40°F.; then temperature lowered to 30°F. for 7 days.
3. Trees subjected to continuous 40°F.; then temperature raised to 65°F. for 7 days.
4. Trees subjected to continuous 40°F.; then temperature lowered to 30°F. and for 7 days raised to 40°F. for 7 days.
5. Trees subjected to continuous 40°F.; then temperature raised to 65°F. and lowered to 40°F. for 7 days.
6. Trees receiving continuous 40°F. measured after all treatments completed.

There were two trees for each treatment. The experiment was conducted in February 1957.

1957-1958

Experiment I - This experiment was designed using many treatments similar to Experiment I the preceding year.

1. Continuous 65°F.
2. Continuous 40°F.
3. Continuous 40°F.; then temperature raised to 65°F. for 1 day.
4. Continuous 40°F.; then temperature raised to 65°F. for 7 days.
5. Continuous 65°F.; then temperature lowered to 40°F. for 1 day.
6. Continuous 65°F.; then temperature lowered to 40°F. for 7 days.

There were five trees per treatment and the test was made at four different times during the dormant season.

Results

The data of the four experiments described are now at the Statistics Department being analyzed statistically. Hence, the average conductivities are presented, but only broad generalizations are made since the statistical analyses are not available.

The larger the electrical conductance value is, the more cell injury has occurred; hence, less cold resistance. The data for the four experiments are recorded in tables 1 to 5.

Table 1. (Expt. 1) Effect of various temperatures on the cold hardiness of peach trees. Each value is a mean of two determinations.

Treatment	Conductance (micromhos) 11/20/56	12/4/56	12/19/56	1/3/57	1/16/57
A. Twigs before freezing					
1. Continuous 65°F.	227.5	420.3	725.0	417.2	487.9
2. Continuous 40°	483.2	996.4	1902.3	1116.8	940.9
3. Continuous 40°, 65° for 1 day	434.7	709.8	1611.8	1329.4	781.3
4. Continuous 40°, 65° for 5 days	267.4	1759.2	3170.7	1499.7	901.5
5. Continuous 40°, 32° for 1 day	1032.6	640.0	1268.2	751.8	472.7
6. Continuous 40°, 32° for 5 days	1395.0	634.0	1114.5	747.5	631.7
B. Twigs after freezing					
1. Continuous 65°F.	1416.5	1841.7	1841.7	1225.9	
2. Continuous 40°	935.6	1648.7	2455.5	1125.0	1796.7
3. Continuous 40°, 65° for 1 day	1946.6	1848.0	1939.4	2048.5	1345.0
4. Continuous 40°, 65° for 5 days	1743.9	1712.1	2069.3	2029.2	1556.9
5. Continuous 40°, 32° for 1 day	1983.3	1747.1	1811.8	962.0	1160.1
6. Continuous 40°, 32° for 5 days	1868.0	1902.3	2515.8	2008.4	1172.2
C. Roots before freezing					
1. Continuous 65°F.	373.1	250.3	477.0	426.4	1405.0
2. Continuous 40°	585.2	332.2	413.9	416.1	1562.7
3. Continuous 40°, 65° for 1 day	411.5	590.6	334.4	492.9	1743.8
4. Continuous 40°, 65° for 5 days	569.6	434.5	300.9	503.7	943.4
5. Continuous 40°, 32° for 1 day	821.4	377.3	360.2	346.7	1635.6
6. Continuous 40°, 32° for 5 days	447.5	533.1	313.4	326.7	1138.8

Table 2. (Expt. 2) Effect of various temperatures on the cold hardiness and survival of peach trees maintained previously at 40° and 65°F. Each value is a mean of two determinations.

Cold treatment for 12 hrs.	Previous temp. treatment	12/22/56		1/19/57		2/23/57	
		Cond.	Survival*	Cond.	Survival	Cond.	Survival
0°F.	40°F.	321.5	1.5	358.8	2.5	406.1	2.5
	65°	666.6	5.0	1160.1	4.5	1177.6	4.5
7°	40°	230.5	1.5	295.4	2.0	410.6	2.5
	65°	599.4	4.0	590.7	4.0	1032.9	4.0
14°	40°	296.5	1.5	262.0	2.5	313.8	1.5
	65°	344.0	4.0	442.1	2.0	871.8	2.5
21°	40°	237.5	1.0	327.3	1.0	287.1	1.0
	65°	337.8	2.0	319.6	2.0	678.8	2.0

*Survival rating: 1 - normal to 5- dead

Table 3. (Expt. 2) A study of various technique procedures using the conductivity method of measuring cold hardiness. Tests conducted January 19, 1957. Each value is a mean of two determinations.

A. The effect of number of 1" twigs used on conductivity readings. Trees in 14°F. twelve hours before samples collected.

No. twigs	Previous cold treatment	Cond.
10	40°F	200.7
	65°	393.7
15	40°	195.5
	65°	368.6
25	40°	262.6
	65°	442.1
50	40°	401.8
	65°	544.7

B. The effect of measuring the electrical conductivity at different time periods. Trees in 0° temperature for 12 hours before samples collected.

Time twigs in Soln.	Previous cold treatment	Cond.
1 hr.	40°F	125.9
	65°	210.6
4 hrs.	40°	224.1
	65°	514.9
8 hrs.	40°	261.5
	65°	676.3
11 hrs.	40°	289.2
	65°	790.7
20 hrs.	40°	311.7
	65°	845.4
24 hrs.	40°	358.8
	65°	1160.1
48 hrs.	40°	475.6
	65°	1646.5

Table 3. (continued)

C. The effect of length of twigs used for electrical conductivity test. Trees in 0°F temperature for twelve hours before twig samples collected.

Size of twigs	No. twigs	Previous cold treatment	Cond.
2 1/2"	10	40°F	175.9
		65°	761.4
1"	25	40°	358.8
		65°	1160.1
1/2"	50	40°	581.7
		65°	1561.9

D. The effect of twig location on electrical conductivity.

Tree Location	Cold temperature for 12 hours	Previous cold treatment	Cond.
Terminal	7°	40°	295.4
		65°	595.7
	21°	40°	327.3
		65°	319.6
Mid-Section	7°	40°	298.8
		65°	491.4
	21°	40°	267.6
		65°	401.0
Base	7°	40°	267.6
		65°	401.0
	21°	No data	

Table 4. (Expt. 3) The effect of intermittent temperature on cold hardiness and survival of peach trees. Each value is a mean of two determinations.

Date	Treatment	Conductivity		Tree Survival*
		Before Freezing	After Freezing	
2/13/57	1. Constant 40°F.	401.5	1197.8	4.0
2/19/57	2. 30° for 7 days after constant 40°	526.4	1103.8	3.5
2/19/57	3. 65° for 7 days after constant 40°	782.4	1024.3	5.0
2/26/57	4. Constant 40°, held at 30° for 7 days - returned to 40° for 7 days before measuring	840.8	1410.6	3.5
2/26/57	5. Constant 40° - held at 65° for 7 days - returned to 40° for 7 days before measuring	595.5	1167.3	5.0
	6. Constant 40° at all times	847.8	1412.3	4.0

*Survival rating: 1- normal to 5- dead

Table 5. (Expt. 4) Effect of various temperatures on the cold hardiness of peach trees. Each value is a mean of five determinations.

	Conductance (micromhos)			
	12/4/57	12/8/57	1/6/58	1/20/58
1. Continuous 65°F.	333.0	432.2	624.9	681.3
2. Continuous 40°	239.0	317.1	236.2	294.2
3. Continuous 40°, 65° for 1 day	232.0	336.7	246.7	341.2
4. Continuous 40°, 65° for 7 days	268.0	353.4	319.0	506.0
5. Continuous 65°, 40° for 1 day	335.4	501.2	390.8	703.6
6. Continuous 65°, 40° for 7 days	254.9	301.4	418.7	493.0

Experiment I

No consistent relationships were present between treatments and dates. It is thought that the experiment did not provide useful data because of the way the trees were handled. The storage rooms were to be available a week before they actually were and the trees were held in the warm hall for this period.

Experiment II

(a) Trees held at 40°F. were considerably more hardy than those held at 65°F. before the freezing tests.

(b) Trees held at 40°F. had about the same electrical conductivity regardless of the cold treatment given them. Conversely, trees held at 65°F. were damaged less with the warmer treatments (21°), although they were always damaged more than trees pretreated at 40°F.

(c) As the season progressed higher conductivity readings were apparent, indicating more damage. This was particularly evident after the rest period requirements had been satisfied.

(d) Regardless of the number of twigs used in the test one received about the same electrical conductivity. This is what one would expect since the amount of water placed with the twigs was in direct proportion with the weight of the twigs.

(e) The longer the twigs were left in the distilled water the higher the electrical conductivity, hence the more solutes going into solution. For this reason a definite time period should be used on all tests.

(f) The location on the tree where the twigs were sampled did not seem to influence the electrical conductivity.

Experiment III

The trees used in this experiment were handled the same as those in Experiment I and there are not any clear cut relationships that are easily seen between treatments.

Experiment IV

(a) Trees held at 40°F. were much hardier than those held at 65°F.

(b) Trees held at 40°F.; then 1 day at 65°F. before chilling, were only slightly less hardy than those held continuously at 40°F.

(c) Trees held at 40°F.; then for 7 days at 65°F. before chilling, were much less hardy than trees held continuously at 40°F.; although more hardy than trees held continuously at 65°F.

(d) Trees held at 65°F.; then 1 day at 40°F. did not gain appreciable hardiness when compared to trees held continuously at 65°F.

(e) Trees held at 65°F.; then for 7 days at 40°F. did increase considerably in cold hardiness from those held continuously at 65°F.

(f) As the season progressed the hardiness of trees held at 40° did not change very much, but the hardiness of trees held at 65°F. decreased considerably. This was the case particularly after the rest period requirement was completed.

Summary

Trees held at lower temperatures (40°F.) are much hardier than trees held at higher temperatures (65°F.). Not much hardiness is lost or gained within 1 day, but considerable is lost or gained within 7 days depending on the temperature changes. The amount of hardiness lost or gained increases after the cold requirement for the rest period has been satisfied. Reducing the temperature of the room the trees were in from 40°F. to 30°F. did not affect the hardiness.

A Study of Growth Substances in Elberta Peach Flower Buds During the Dormant Season

Growth substances, sometimes referred to as hormones, are found in minute quantities in plants yet they have a profound influence on growth. These "chemical messengers" are produced by the plant and are translocated through living cells to other regions of the plant. It is thought by many that growth substances initiate the growth in the spring of plants. Growth substances were extracted from peach buds at intervals during the dormant season to determine what effect they had on growth.

The peach buds were collected from mid-August to mid-December at two week intervals and from mid-December to bloom in March at weekly intervals. They were collected often during the year to determine if the growth promoting and/or growth inhibiting substances changed in concentration during the dormant season.

Before an accurate test of the growth substances could be made the chemical techniques for the study had to be worked out. The purification, and separation aspects of the problem were determined after some chemical studies, but the evaluations of the chromatograms were difficult, since a given known compound had a different Rf value when run on different days. Dr. D. D. Mason and Dr. G. W. Snedecor of the Statistics department were consulted and it seemed advisable to first study this source of variation before proceeding with the seasonal collection of peach buds. Dr. G. W. Snedecor, father of Statistics in America, agreed to study the problem in detail with us. The results of this study were presented at the annual meetings at Palo Alto, California and have been accepted by Plant Physiology for publication. A copy of the paper is in the appendix of this report.

The seasonal study has confirmed the data of the past two seasons that a definite growth inhibitor is present in peach flower buds during the dormant season. The growth inhibitor has been present in all runs and inhibits growth of wheat coleoptiles considerably when compared with the untreated controls. Although, there have been a few runs when it appeared a possible growth promoter was present; the indication has not been very strong. The possible promoter was present in only a few runs. These runs

were with peach buds that were not collected on consecutive dates. There have been indications that our biological assay test is very sensitive to growth inhibitors but not very good for growth promoters. Other biological assays are now being studied that may be better adapted to measuring growth promoters.

Laboratory tests have shown that the concentration of the inhibitor has not varied much throughout the dormant season. This however may not be the actual case, since the coleoptiles generally have been nearly completely inhibited. A much smaller concentration of inhibitor placed with the buds may give a different picture. Early in August we settled on a sample size of one gram of buds. Dilution studies have revealed that the inhibitor extracted from one-tenth gram of buds inhibits wheat coleoptiles nearly as much as that extracted from one gram of buds. The inhibitor from one-hundredth gram of buds did not inhibit the growth of coleoptiles.

Dilution studies from many samples of buds will be made to determine if the concentration of the inhibitor does change during the dormant season. This will be correlated with the rest period requirement in peach buds.

An extensive study has been made in an attempt to identify the growth inhibitor. A number of chemical and biological tests have been made, but one is always faced with separating it completely from other substances and in obtaining enough to measure. The following are a few characteristics of the inhibitor:

(a) Stable in strong acid and base solutions.

(b) Stable to heat; it was boiled for many minutes and did not lose its inhibiting properties.

(c) Completely soluble in acid fraction and partially soluble in the basic fraction.

(d) It will not move with water as the chromatographic solvent; it requires an alcohol or similar organic solvent for movement.

(e) The paper chromatograms showed no color reaction when Ehrlichs, Salkowski or $NaNO_2$ reagents were sprayed on the paper containing it. This indicates there is probably not a indole ring in the structure.

(f) Mr. Arvel Hunter, Agronomy Department, has analyzed it for cyanide. It gave a positive test for cyanide, but since he uses such strong acids for this determination this only means that there is carbon and nitrogen present; which probably is in the form of a nitrile group.

(g) The inhibitor fluoreces a dark purple under an ultra violet light.

(h) It is found in paper chromatograms at Rf .4-.6 using butanol, ammonia and water as a solvent.

(i) Dr. Weybrew, Head of the Chemistry Departments research, has run an ultra violet spectrum of it on his instruments. A number of possible compounds it might have been were run with the unknown, but the inhibitor was not any of these.

(j) Buds dried at room temperature for 3 days had the same concentration of inhibitor as did fresh buds.

(k) Dr. S. B. Knight, Chemistry Department at University of North Carolina, has run an infra red spectrum on the inhibitor and found the following groups present: (1) a napthalene ring, (2) an aldehyde or ketone group on the side chain, (3) a primary or secondary amine group.

(l) This substantiates data found from the ultra violet spectrum that napthalene is present. Also that nitrogen is present.

(m) Charles Hendershott has made a few other chemical tests in addition to the above.

It is hoped with the infra red spectrum that the Eastern Regional Laboratory or Stadlers Chemical Corporation will compare the inhibitors spectrum with the 20,000 or more known compounds they have spectrums for, using their IBM sorting equipment.

After this inhibitor has been identified and synthesized it will be sprayed on dormant peach buds. There is the possibility that by increasing the concentration of the inhibitor in the plant; it will bloom later in the season and avoid early spring freezes. The possibility of trees not blooming after application of the inhibitor is present. In this case gibberellic acid can be applied which has been shown to act as a growth promoter of dormant peach buds.

In the south especially there are a number of warm periods in the spring inducing bud growth. The buds are then often killed when a cold snap comes. The loss of peach crops by spring freezes has cost growers in the nation millions of dollars. Controlling growth of the buds in the spring may be the answer in avoiding future peach crop failures. There is also the possibility that the inhibitor may be used for other purposes such as weed killing.

The Effect of Gibberellic Acid on the Breaking of the Rest Period
In the Elberta Peach and Delicious Apple

Details of a preliminary experiment were published in Science. A reprint of this paper can be found in the appendix. A more extensive study was undertaken this year.

Trees that had been held at either 40°F. or 65°F. were sprayed with gibberellic acid at different times during the dormant season. Four concentrations (0, 100, 500, and 1,000 ppm) of gibberellic acid were used. Three trees (replications) were sprayed with one of the above concentrations. Each tree received two spray applications of the treatment assigned to it. Below is a brief summary of the experiments ~~undertaken~~ conducted:

Peaches

a. Prestorage treatment : 40°F. and 65°F.

b. Concentrations used: 0, 100, 500 and 1,000 ppm.

c. Replications: Three per treatment

d. Above treatments repeated three times during dormant season.

e. Two applications at 10 day intervals per treatment.

Apples

a. Prestorage treatment: 40°F.

b. Concentrations used: 0, 1000 and 4000 ppm

c. Replications: Two per treatment

d. Above treatments repeated three times during dormant season.

e. Two applications at 10 day intervals per treatment.

The number of leaf buds, flower buds, average length of shoots, leaf injury and longest shoot growth were recorded at 20, 40 and 60 days after gibberellic acid (GA) applications.

The data has not been analyzed statistically, hence only general comments will be made on the results.

Results

Peaches

a. No difference in the amount of foliage between trees pretreated with 40°F. or 65°F. rooms, that were sprayed with 500 and 1000 ppm GA.

b. Trees sprayed with 100 ppm GA were much slower in leafing out than trees receiving the 500 or 1000 ppm GA.

c. Trees pretreated at 40°F. sprayed with 100 ppm GA leafed out much sooner than trees pretreated at 65°F. and sprayed with 100 ppm GA.

d. Trees sprayed with 1,000 ppm GA had slightly longer internodes than trees sprayed with 500 ppm GA.

e. Flowers on the trees sprayed with 500 and 1,000 ppm GA had longer stems than those on trees sprayed with 100 ppm GA. The flower stems on the trees sprayed with 100 ppm GA were normal length.

f. The untreated control trees pretreated at 65°F. did not leaf out at all.

g. The untreated control trees pretreated at 40°F. for 2 weeks did not leaf out at all. Those held in the 40°F. storage room did leaf out, but much slower than trees pretreated at 40°F. and sprayed with 100 ppm GA. They also leafed out slower than trees pretreated at 65°F. and sprayed with 100 ppm GA.

h. The leaf buds came out before the flower buds on trees sprayed with 500 and 1000 ppm GA. This is not the usual pattern. The flower buds came out before the leaf buds on trees sprayed with 100 ppm GA which is the normal pattern.

i. Trees sprayed with GA had not received sufficient cold to "break" the rest period leafed out, but most of the leaves were narrow and came from the terminals.

Apples

a. Only terminal buds and some laterals near the terminals leafed out from trees sprayed with 4,000 ppm GA.

b. Only the terminal leaf buds and not the lateral ones leafed out on trees sprayed with 1000 ppm GA.

c. The untreated control trees did not leaf out at all.

d. No difference was noted between trees that were treated with similar concentrations of GA but received a different number of hours at 40°F. before treatment.

Project S-168 - The effect of different nitrogen levels and time of application on mature apple trees in North Carolina.

The work covered in this project has been divided into the following sub-groups for presentation: (1) Nitrogen fertilizer studies - detailed experiments; (2) Boron and zinc fertilizer studies; and (3) a report on the nutritional status of apple orchards in North Carolina and a method of selecting orchards for random sampling. The nutritional survey paper is nearly in its completed form and soon will be submitted to the American Society for Horticultural Science for publication in the proceedings.

Nitrogen fertilizer studies - detailed experiments:

Four orchards were selected for fertilizer treatments after fertility levels of many orchards were determined. Treatments in the four orchards were first established in the spring of 1956. Considerable time has been spent in these orchards collecting leaf samples for chemical analyses and harvesting the fruit. The following measurements were recorded from the trees in 1957; leaf nitrogen, weight and area; and fruit size, weight, color, yield, soluble solids and firmness. In two of the four orchards leaf phosphorus and potassium were also determined.

In two of the orchards, (Blair's, Taylorsville and Schnyder's, Hendersonville) there are ten treatments replicated four times in each orchard. Thus, there are 40 trees under observation at each location. In the other two orchards (Eavenson's, Waynesville and Broyhill's, Wilkesboro), there are smaller tests underway. There are four treatments replicated three times at Eavenson's and four times at Broyhill's. Thus, there are 28 trees under observation in these two orchards. The fertilizer treatments applied to the trees each year are as follows:

A. Blair and Schnyder Orchards

1. .50# N soil application in spring
2. 1.00# N soil application in spring
3. 1.50# N soil application in spring
4. 2.00# N soil application in spring
5. 1.00# N urea spray application in spring

6. .50# N urea spray application in spring
7. 1.00# N soil application in fall
8. 2.00# N soil application in fall
9. 1.00# N split soil application with 1/2 applied in the fall and 1/2 in the spring
10. 2.00# N split soil application with 1/2 applied in the fall and 1/2 in the spring

B. Eavenson and Broyhill Orchards

1. nitrogen fertilizer
2. nitrogen and phosphorus fertilizer
3. nitrogen and potassium fertilizer
4. nitrogen, phosphorus and potassium fertilizer

The results from the nitrogen studies have not provided much information as yet, concerning which treatment would be the best for North Carolina. Of all the criteria measured, the leaf nitrogen was the only one significant when the data from the Blair and Schnyder orchards were pooled and statistically analyzed. Trees receiving .50# nitrogen (urea foliar or soil applied) contained less leaf nitrogen than did the other trees. Differences between times of application (fall, split or spring) of nitrogen have not been apparent.

The results from the nitrogen, phosphorus and potassium fertilizer experiment (Eavenson and Broyhill orchards) showed differences between treatments only in leaf potassium. Trees receiving the nitrogen and potassium treatment had significantly more potassium in their leaves than trees not receiving potassium. There were apparently no other differences between treatments for the criterion measured.

Two years data (1956 and 1957) have been collected for this project. Although, considerable time has been spent in the field and laboratory collecting and processing the leaves and fruit there has not been a great deal of information that can be used for fertilizer recommendations to the grower. The reason the trees have not responded to the various fertilizer treatments is unknown. Possibly, the trees had a reserve supply of nutrients that must be depleted before differential fertilizer treatments are apparent in tree performance. It is hoped differences between the trees receiving the differential treatments will be apparent in 1958, the third year for the experiment.

Table 1. The effect of various nitrogen fertilizer treatments on apple leaf and fruit characteristics. Data combined from Schnyder and Blair orchards. Each value is a mean of 8 determinations.

Treatment	Leaf Nitrogen (% d.w.)	Wt. 30 Leaves (g)	Leaf area of 30 leaves (sq. cm.)	Yield (bu)	Wt.25 Fruit (lbs.)	Size of Fruit[a]	Soluble Solids (%)	Pressure Test (lbs.)	Fruit color[b]
1. .50# N Soil Spring	1.88	10.10	1099	2.75	7.66	75.3	16.35	9.45	5.50
2. 1.0# N Soil Spring	1.97	10.42	1088	6.88	8.64	85.0	15.20	9.08	5.25
3. 1.5# N Soil Spring	2.01	9.92	1024	3.88	6.96	69.5	16.52	9.29	5.75
4. 2.0# N Soil Spring	2.10	10.38	1051	6.88	7.86	73.8	16.15	9.61	5.50
5. 1.0# N Urea Spring	2.06	9.71	1047	3.63	8.18	78.5	16.08	9.81	5.00
6. .50# N Urea Spring	1.86	9.83	1057	3.00	7.62	68.8	17.78	10.31	6.25
7. 1.0# N Soil Fall	1.92	10.11	1062	4.25	8.06	80.5	17.45	10.11	6.25
8. 2.0# N Soil Fall	2.02	10.15	1047	3.13	8.49	82.5	16.62	9.60	6.00
9. 1.0# N Soil Split	1.96	10.04	1068	6.38	9.11	91.8	16.00	9.81	5.75
10. 2.0# N Soil Split	2.05	10.80	1099	2.63	8.63	82.8	14.20	10.00	5.50
L.S.D. .05	.09	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
.01	.12								

[a]rated scale - the larger values represent larger fruit
[b]rated scale - 1 poor color - 10 excellent color

Table 2. The effect of various nitrogen fertilizer treatments on apple leaf and fruit characteristics. Data combined from Eavenson and Broyhill orchards. Each value is a mean of 8 determinations.

Treat-ments	Leaf Nitrogen (% d.w.)	Leaf P_2O_5 (%d.w.)	Leaf K_2O (%d.w.)	Wt. 30 Leaves (g)	Leaf area of 30 leaves (sq. cm.)	Yield[c] (bu.)	Wt.25 Fruit (lbs.)	Size of Fruit[a]	Soluble Solids (%)	Pressure Test (lbs.)	Fruit color[b]
1. N	2.00	.33	1.47	9.16	934	24.0	8.34	84.43	14.54	9.53	5.14
2. NP	2.07	.35	1.37	9.57	984	19.7	8.54	87.29	13.94	9.91	5.71
3. NK	2.02	.31	1.68	9.78	1021	22.3	8.42	85.71	14.54	10.12	6.29
4. NPK	2.02	.33	1.57	10.37	991	32.7	8.49	86.29	14.20	9.97	5.86
L.S.D. .05	N.S.	N.S.	.15	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
.01			.21								

[a]rated scale - the larger values represent larger fruit
[b]rated scale - 1 poor color - 10 excellent color
[c]yield for only Eavenson's trees (values average of 3 determinations)

Boron and zinc fertilizer studies: Boron and zinc apparently are at a low level in many orchards in the state. A study of different fertilizer treatments containing these elements has been undertaken in two orchards. The boron treatments were established in Mr. Otho Lyda's orchard near Hendersonville last year. Each one of the following treatments ~~was~~ were replicated four times using mature apple trees:

1. 1/2# borax on soil every third year
2. 1 1/2# borax on soil every third year
3. untreated control
4. Foliar spray of 2#/100 gal. Polybor; two applications after bloom each year.
5. 1/2# borax on soil each year

This orchard was very deficient in boron when it was called to our attention. Most of the fruit had boron deficient symptoms of small misshappen, russetted fruit with brown dead cells inside of the fruit. In 1957, after the boron treatments were applied, there were very few deficiency symptoms present. Most of the fruit did not have any of the symptoms mentioned above. Table 1 indicates that the leaf boron increased considerably in all trees in 1957 whether boron was applied or not. The only reason that can be given for the untreated trees increasing in leaf boron in 1957 is the varying weather conditions from season to season.

The orchard suspected of being deficient in zinc under study is the Andrews orchard located near Wilkesboro (Boomer). In 1956 the trees appeared extremely deficient in zinc, hence zinc treatments were applied March 16, 1957. The following three treatments were each replicated on 6 trees in the orchard:

1. 5# zinc sulfate applied to soil
2. zinc sulfate dormant spray (25# $ZnSO_4$/100 gal.)
3. untreated control

Leaf samples were collected from the trees in July, 1957 and are to be analyzed for zinc in the near future.

Another orchard not growing well that has been called to our attention is that of Mr. Fitzhugh's in Cherryville, N. C. Boron deficiency was suspected in the orchard, hence foliar sprays and soil applications of boron were applied in the spring of 1956. Leaf

samples were collected after the boron treatments had been applied and they contained large amounts of boron in the leaves yet the bark had many internal necrosis areas similar to boron deficiency symptoms.

Lithium is mined from the soil in the area and the possibility of lithium toxicity was checked. Leaf samples from this orchard did not contain greater amounts of lithium than did leaf samples from trees growing very well in other parts of the state. The reason for the poor tree performance in this orchard has not been determined but will be studied again this year.

Table 1. The effect of boron fertilizer applications on boron deficient apple trees. Boron treatments applied March 14, 1957. Each value is a mean of four determinations.

Treatment	Leaf Boron (% d.w.) Before Treatment 9/11/56	After treatment 7/17/57
1. 1/2# borax on soil	20.3	58.0
2. 1 1/2# borax on soil	16.5	75.5
3. Untreated control	22.5	47.8
4. Polybor foliar spray	16.0	78.0
5. 1/2# borax on soil each year	14.3	56.3

The Nutritional Status of Apple Orchards in North Carolina And a Method of Selecting Orchards for Random Sampling

The nutritional status of apple trees has been determined in many states by use of leaf analysis surveys. The results of these surveys have been correlated with proposed critical levels to determine the nutrient-element deficiencies. These proposed levels have evolved from the experience of many investigators correlating deficiency symptoms with the nutrient-element levels in the leaves. Sampling procedures and analytical methods have been standardized allowing comparisons between laboratories. Kenworthy (3) found that by having many laboratories analyze similar samples, values reported for macro elements could be compared between laboratories, but that considerable variation occurred in analyses of minor elements.

The selection of orchards for leaf sampling greatly influences the findings of a nutritional survey. Since a satisfactory method of selecting orchards for a general survey has not been reported two possible methods were used of which the second proved satisfactory. Leaf samples were collected for this nutritional survey during the summers of 1955 and 1956.

MATERIALS AND METHODS

Selection of Orchards In 1955 extension county agents were asked to help in selecting orchards for leaf sampling. They were instructed to select orchards that would represent the average nutritional conditions in the county. Three varieties, Red Delicious, Golden Delicious and Stayman, were sampled in each of 39 orchards in 1955. While collecting the samples it was felt that the better orchards or the orchards owned by the more prominent people in the county were selected for sampling. In addition, limiting the sampling to orchards having all three varieties did not allow for random selections.

In 1956 another method was used in selecting apple orchards for sampling. A list of the ages, and numbers of trees of each variety all growers owned was obtained. From

The author is indebted to the departments of Chemistry and Experimental Statistics for the chemical and statistical analyses respectively.

this list, growers having a total of at least 500 trees of the varieties Red Delicious, Golden Delicious, Rome Beauty or Stayman were chosen as the sampling population. These four varieties are the major ones grown in the state and accounted for 74.1 per cent of the production in 1954. The number of trees of a given variety in an orchard were divided into sampling units of ten trees each. The units for each variety were grouped together and a random sampling of them was made. Consequently orchards with a large number of trees had a greater chance of being randomly drawn.

In the random sampling leaf samples of more than one variety were drawn in a few orchards and in two cases two leaf samples of one variety were drawn from the same orchard. Leaf samples were collected from eighty-nine orchards in 1956. Selecting orchards in this manner led us to more variable fertility situations than the previous year.

In 1956 ten leaf samples (50 leaves per sample) of each of the four varieties were selected in each of the four main apple producing counties of the state. Thus in the main apple producing counties a 4 x 4 factorial experiment was established. An exception to this was made for two of the counties having insufficient numbers of the Rome Beauty variety. Four other counties of minor importance in apple production were also sampled, but were not included in the factorial analysis. The counties sampled produced 84 per cent of the apples produced in the state in 1954.

For a comparison of the 1955 and 1956 seasons, trees from twenty orchards sampled in 1955 were again sampled in 1956; Red Delicious, Golden Delicious, and Stayman varieties were sampled in each orchard. Some of the orchards used in this study were also randomly drawn for the 1956 4 x 4 factorial.

At each orchard during both years, growers were interviewed concerning their fertilizer program. Leaf samples were later grouped into two subgroups for fertility comparisons; samples collected from trees receiving only nitrogen and those receiving a complete fertilizer.

Methods of sampling and analysis Trees used in the survey ranged in age from 12 to 30 years. Mid-shoot leaves were sampled around the periphery of the tree at chest height during the first three weeks in August of each year. In 1955 ten leaves were selected from ten trees in an orchard and composited for one sample. In 1956 five leaves from ten trees comprised a sample. The leaves were placed in polyethylene bags and cooled in ice chests until they were returned to the laboratory where they were individually washed in tap water, dried and ground in a Wiley mill before analysis. Potassium, phosphorus, calcium, magnesium, iron, manganese and copper were determined spectrographically. Nitrogen, boron and zinc were determined by the Kjeldahl, Naftel (4) and Zincon (5) procedures respectively. Data are expressed on a dry weight basis.

Soil samples at the 0-6" depth were also collected in the orchards. Two cores from each of nine trees were taken beneath the drips of the branches. Additional samples (eighteen cores) were taken in the row middles at the 0-6" depth. The cores from the two locations were composited separately for each orchard. Soil pH measurements were made using a soil to water ratio of 1:1. Other soil analyses were made and will be discussed in a future paper.

RESULTS AND DISCUSSION

In order to interpret the chemical analyses they must be related to something known, such as the nutrient-element levels present when deficiency symptoms exist. In this paper Emmert's (2) lower critical nutrient-element levels were used in evaluating the nutritional status of the macro elements in the leaf samples. Emmert's levels were established after averaging values reported for trees growing well and from many state nutritional surveys conducted mainly in eastern United States.

A critical level of 22 ppm boron was used. Many other investigators (1, 6) have considered the boron critical level to be between 20 and 30 ppm. The writer has observed boron deficient fruit on trees whose leaves contained 15 ppm boron. Critical levels for manganese, iron, copper or zinc in apple leaves are not given. Insufficient data are available to determine critical levels for these nutrient-elements.

1955 Nutrient-element levels In table 1 the mean 1955 nutrient-element levels are compared with the proposed critical levels. Leaf calcium, magnesium and nitrogen were low in less than 20 per cent of the orchards. Leaf boron and phosphorus were the two nutrient-elements that were low in a large percent of the orchards. Over one-half of the leaf samples were lower in boron than the proposed critical level of 22 ppm. However, fruit symptoms of boron deficiency in 1955 were not observed since no crop remained after the spring freeze. Leaf phosphorus was lower in 88 per cent of the orchards than the proposed critical level. The average leaf phosphorus was .15 per cent dry weight in the 1955.

1956 Nutrient-element levels The percentage of orchards with foliage low in potassium, magnesium and calcium increased in 1956 when compared with the previous year (Table 1 and Figure 1). The reason for this is not completely known, although changing the method of selecting orchards for sampling is shown subsequently to contribute materially and there being a crop in 1956 and not in 1955 is also an important factor to consider. The magnesium content of leaves appears to be approaching the critical level in many orchards. Symptoms have been observed in a few orchards; many no doubt, are at the stage of an incipient deficiency.

There was a lower percentage of leaf samples below the boron critical level in 1956 than in 1955. However, many orchards did have boron deficiency symptoms of corky, misshappen small fruit. Small, narrow leaves typical of zinc deficiency were also evident in two orchards. Leaf zinc was 4.5 and 5.0 ppm in the samples from the two orchards. The analysis of leaves from four other orchards showed they contained less zinc then the leaves from the two orchards exhibiting the deficiency symptoms. Possibly many of the orchards were near the critical level of this nutrient-element since a large percentage (44%) of the samples contained less than 11 ppm zinc.

In 1956 phosphorus was also low in a large number of the leaf samples. Fifty-eight per cent of the samples were below the proposed critical level of .18 per cent dry weight. Data presented subsequently indicate that possibly this critical level is

higher than is necessary for at least North Carolina conditions. Deficiency symptoms of phosphorus were not observed, although very low levels (.11%) were present in the foliage of some of the orchards. The pH of the soil samples collected beneath the trees averaged (using hydrogen ion concentrations) 5.6; 28 per cent of the samples had a pH value below 5.5. Samples collected in row middles averaged pH 5.8 with only 9 per cent of the samples below pH 5.5.

In 1956 variety and county 4 x 4 factorial There were no differences between the leaves of the four varieties in nutrient-element levels of calcium, magnesium, copper, iron and zinc in the 1956 factorial (Table 2). The leaves collected from the Stayman trees were lower in nitrogen, phosphorus and manganese than most of the other varieties. Red Delicious leaves contained a greater amount of boron than the other varieties, while Red and Golden Delicious varieties had significantly more potassium than did Stayman or Rome Beauty.

County comparison showed that the leaf samples collected from the two north western counties (Alexander and Wilkes) were generally lower in the nutrient-elements than were the two counties located in the southwest (Haywood and Henderson). Wilkes county leaf samples in comparison with the other counties were particularly low in phosphorus, potassium, calcium and iron.

The only variety by county interactions that occurred were with phosphorus and calcium. The nutrient levels of these nutrient-elements varied between varieties and counties more than the other nutrient-elements.

Comparison of twenty orchards in 1955 and 1956 In comparing the nutrient-element levels of the twenty orchards sampled in 1955 and 1956, the crop and weather conditions should be considered. As previously mentioned, the 1955 apple crop was destroyed by a spring frost. The season was otherwise "normal" with sufficient moisture. In 1956 there was an ample crop. The 1956 leaf samples were collected two weeks after a rain, although there were no signs of moisture stress exhibited by the trees. These conditions may have greatly influenced the nutrient-element content of the apple leaves.

Leaf samples taken in 1956 from the twenty orchards were significantly higher in nitrogen, phosphorus, manganese, copper, iron and boron than the 1955 leaf samples (Table 3). However, the 1955 leaf samples were significantly higher in potassium and calcium than the 1956 samples. Leaf magnesium and zinc were similar in both years.

In both years the Red and Golden Delicious leaves collected in the same orchards were higher than Stayman leaves in leaf nitrogen, potassium and boron (Table 4). Golden Delicious leaves contained a greater quantity of potassium, and manganese than the other varieties in both years. The phosphorus, magnesium, copper, iron and zinc contents were similar in all varieties sampled in these twenty orchards. The only year by variety interactions that occurred were with potassium and boron. The nutrient levels of these nutrient-elements varied between years and varieties more than the other nutrient-elements.

Comparison of coefficients of variation The coefficients of variation of each of the nutrient-element levels were in all cases, except zinc, larger in 1956 than in 1955 (Table 4). In many cases they were more than twice as large as in 1955. This difference between 1955 and 1956 data can not be completely explained as merely a seasonal difference since the coefficients of variation for the macro elements for the twenty orchards sampled both years were considerably less than the 1956 coefficients of variation. This indicates that a considerably more variable sampling population was present in 1956, hence it constitutes a better estimate of the nutritional status of apple orchards in the state as a whole.

Phosphorus and Potassium Applied vs. Not Applied Of the growers interviewed, approximately one-half applied a complete fertilizer (NPK) and the other one-half applied nitrogen only. There were essentially no difference in leaf phosphorus or potassium between samples of leaves that had or had not received phosphorus or potassium fertilizers respectively (Table 5). Leaf nitrogen, magnesium and calcium were also at approximately the same level whether phosphorus or potassium had been applied or not.

The average leaf potassium levels during 1955 and 1956 were considerably above the proposed critical level. The average leaf phosphorus levels, on the other hand, are lower than the proposed critical level, although trees have apparently not responded from applications of phosphorus indicated by leaf analysis. Possibly, less phosphorus is required in apple trees than the proposed critical level indicates.

SUMMARY

Leaf samples were collected in 1955 and 1956 and analyzed to determine the nutritional status of apple orchards in North Carolina. A method is described for selecting orchards at random for a general survey of this type. Selecting orchards in this manner led to many places that would not ordinarily be chosen for sampling. The large coefficient of variation between samples in 1956 when compared with the non-random selection of orchards made in 1955 indicates that a more variable population was considered when selecting the orchards at random.

Leaf analysis and nutrient-element deficiency symptoms of apple trees in North Carolina indicated that nitrogen, boron and some magnesium deficiencies were present. Zinc deficiency symptoms were also found in two orchards and zinc was low in many leaf samples. The soil pH beneath the trees averaged 5.6; 28 per cent of the soil samples were below pH 5.5.

From interviews with growers and leaf analyses it appeared that growers applying nitrogen were receiving as much benefit as those applying nitrogen, phosphorus and potassium. A large percentage of the leaf samples contained less phosphorus than the proposed critical level. It is suggested that the proposed critical level for phosphorus in mature apple trees is higher than necessary.

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Figure 1. Diagrams showing the nutrient-element content of apple leaves collected in 1956. The hashed bars represent samples below the proposed critical level.

Table 1. Percent of apple leaf samples collected in 1955 and 1956 below a proposed critical (apple) leaf nutrient-element level for apple; and a comparison of seasonal (the two seasons mean apple leaf) nutrient-element levels.

Nutrient Element	Proposed critical level	Samples below critical level[a]		Mean nutrient level of samples[a]	
		1955	1956	1955	1956
	(% d.w.)	(percent)		(% d.w.)	
Nitrogen	1.9	19	16	2.02	2.04
Phosphorus	.18	88	58	.15	.18
Potassium	1.2	1	29	1.64	1.32
Calcium	1.0	13	58	1.18	.96
Magnesium	.24	8	29	.29	.28
	(ppm d.w.)			(ppm d.w.)	
Manganese	b			47	57
Copper				8	35
Iron				73	136
Boron	22	58	23	21	30
Zinc				12	12

[a]Based on 109 and 212 leaf samples in 1955 and 1956 respectively.

[b]Proposed critical levels not established.

Table 2. Mean apple leaf nutrient-element levels of four varieties sampled in 1956.

Nutrient Element	Red Delicious[a]	Golden Delicious[a]	Stayman[a]	Rome Beauty[b]	L. S. D. .05	L. S. D. .01
% d.w.						
Nitrogen	2.09	2.07	1.98	2.12	.07	.09
Phosphorus	.19	.18	.17	.20	.02	.03
Potassium	1.48	1.44	1.32	1.31	.10	.13
Calcium	.94	1.00	.93	1.12	N.S.	
Magnesium	.28	.30	.27	.26	N.S.	
ppm d.w.						
Manganese	54.9	60.2	49.1	59.3	7.0	9.2
Copper	53.8	40.4	46.3	35.4	N.S.	
Iron	129.	134.	138.	133.	N.S.	
Boron	35.2	30.7	30.6	31.0	3.3	4.4
Zinc	12.6	11.9	13.7	11.8	N.S.	

[a]Each value represents a mean of 40 samples

[b]Each value represents a mean of 20 samples

Table 3. Mean apple leaf nutrient-element levels of three varieties sampled in the same twenty orchards in 1955 and 1956.

	Per cent dry wt.					ppm dry wt.				
	N	P	K	Ca	Mg	Mn	Cu	Fe	B	Zn
Year										
1955	2.05[a]	.14	1.62	1.14	.30	206	10	75	20	12
1956	2.13	.17	1.32	.94	.30	244	41	140	32	12
LSD .05	.05	.008	.07	.08	N.S.	5	10	15	2.6	N.S.
.01	.06	.011	.09	.11		7	13	20	3.5	
Variety										
Red Delicious	2.12[b]	.15	1.50	.96	.30	50	25	105	27	12
Golden Delicious	2.13	.16	1.61	1.09	.31	61	29	107	28	13
Stayman	2.03	.15	1.30	1.08	.31	47	23	112	23	13
LSD .05	.06	N.S.	.09	.10	N.S.	7.6	N.S.	N.S.	2.8	N.S.
.01	.08		.12	.14		10.2			3.8	
Year x Variety			**						**	

[a]Each value represents the mean of 60 samples.

[b]Each value represents the mean of 40 samples.

Table 4. Coefficient of variation of nutrient-elements present in apple leaves collected in 1955 and 1956.

Nutrient Element	1955[a] non-random	1956[b] Random	Twenty Orchards[c] Sampled 1955 and 1956
(% dry wt.)	(%)	(%)	(%)
Nitrogen	6	8	6
Phosphorus	9	18	13
Potassium	9	16	12
Calcium	13	28	19
Magnesium	12	24	21
(ppm dry wt.)			
Manganese	18	29	24
Iron	13	34	36
Boron	23	24	25
Zinc	59	47	63

[a]108 samples in analysis
[b]140 samples in analysis
[c]120 samples in analysis

Table 5. Leaf phosphorus and potassium (per cent dry wt.) of apple trees fertilized and not fertilized with phosphorus and potassium respectively.

Treatment	1955 No. Samples	1955 Nutrient Content (% d.w.)	1956 No. Samples	1956 Nutrient Content (% d.w.)
A. Phosphorus				
Phosphorus applied	52	.152	81	.183
Phosphorus not applied	57	.145	114	.174
L.S.D.		N.S.		N.S.
Coefficient of variation		16.6%		19.0%
B. Potassium				
Potassium applied	51	1.65	81	1.33
Potassium not applied	58	1.63	114	1.31
L.S.D.		N.S.		N.S.
Coefficient of variation		10.6%		16.6%

Project S-150. Pruning Investigations of Apples

The effect of different pruning and nitrogen treatments are being studied on young Golden Delicious apple trees at the Mountain Research Station at Waynesville and on mature Starking Delicious trees at Mr. Bert Lytle's orchard near Hendersonville.

Lytle's Orchard: Pruning-nitrogen fertilizer treatments were begun in the spring of 1955 in this orchard. Four treatments were established with six trees per treatment. The treatments were as follows:

1. Light Pruning + 1.50# nitrogen
2. Light Pruning + .50# nitrogen
3. Heavy Pruning + 1.50# nitrogen
4. Heavy Pruning + .50# nitrogen

The criteria used to measure tree performance in the nitrogen field plots were also used in this orchard. There were no differences between the four treatments for the nine criteria studied. These data are summarized in Table 1.

Mountain Research Station: Two levels of pruning and four levels of nitrogen were established on young Golden Delicious apple trees at the Mountain Research Station in 1955. Leaf samples have been collected each year from the 64 trees in the experiment. The data are now at the Statistics Department being analyzed, hence are not included in this report.

Table 1. The effect of various pruning and nitrogen treatments on apple leaf and fruit characteristics in Lytle's orchard. Each value is a mean of 6 determinations.

Treatment	Leaf Nitrogen (% d.w.)	Wt. 30 Leaves (g)	Leaf area of 30 leaves (sq. cm.)	Yield (bu.)	Wt.25 fruit (lbs.)	Size of fruit[a]	Soluble Solids (%)	Pressure Test (lbs.)	Fruit color[b]
1. Light Pruning - Heavy Nitrogen	2.33	7.81	826	6.08	7.12	70.3	14.71	10.56	4.33
2. Light Pruning - Light Nitrogen	2.28	7.12	761	6.92	7.61	75.2	14.80	10.59	3.83
3. Heavy Pruning - Heavy Nitrogen	2.23	7.54	808	4.42	7.37	73.7	15.75	10.69	4.33
4. Heavy Pruning - Light Nitrogen	2.27	7.48	825	4.66	7.35	79.0	14.81	10.25	4.83
L.S.D. .05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
.01									

[a]rated scale - the larger values represent larger fruit

[b]rated scale - 1 poor color; 10 excellent color

A Study of the Nutrient-Element Variability of Apple Leaves
And the Optimum Number of Leaves for a Sample

A study independent of pruning investigations but a very important factor in interpreting tree response has been undertaken in cooperation with Dr. D. D. Mason. This study involves measuring the nutrient-element variation that occurs between leaf samples collected on the same tree and between similar trees.

Four apple orchards were selected for this study near Hendersonville (Nesbitt, Motes, Berry Laughter and Clancy Laughter). Fifteen trees of each Stayman and Delicious were selected in each orchard for the study. Trees were chosen which appeared "normal" in all respects, and ~~in~~ uniform in size. Three leaf samples were collected from each tree to determine the variation that occurred within a tree. Besides the variation within a tree, the variation which occurs between trees, varieties and orchards will be determined. It is felt that although leaf analysis work has been the basis for fertilizer recommendations for many years, little information is available concerning the variability of leaf samples collected from the same or similar trees.

Leaf samples were collected in 1957 from the orchards mentioned above. A second set of samples will be collected in 1958, which will provide two years data before publication. The leaves collected in 1957 have been analyzed for nitrogen, phosphorus, potassium, calcium and magnesium. The data are now at the statistical laboratory being analyzed and are not available for this report.

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A study independent of pruning investigations but a very important factor in interpreting tree response has been undertaken in cooperation with Dr. D. D. Mason. This study involves measuring the nutrient-element variation that occurs between leaf samples collected on the same tree and between similar trees.

Four apple orchards were selected for this study near Hendersonville (Nesbitt, Motes, Berry Laughter and Clancy Laughter). Fifteen trees of each Stayman and Delicious were selected in each orchard for the study. Trees were chosen which appeared "normal" in all respects, and ~~in~~ uniform in size. Three leaf samples were collected from each tree to determine the variation that occurred within a tree. Besides the variation within a tree, the variation which occurs between trees, varieties and orchards will be determined. It is felt that although leaf analysis work has been the basis for fertilizer recommendations for many years, little information is available concerning the variability of leaf samples collected from the same or similar trees.

Leaf samples were collected in 1957 from the orchards mentioned above. A second set of samples will be collected in 1958, which will provide two years data before publication. The leaves collected in 1957 have been analyzed for nitrogen, phosphorus, potassium, calcium and magnesium. The data are now at the statistical laboratory being analyzed and are not available for this report.

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Effect of Gibberellic Acid on Breaking of Rest Period in Elberta Peach

Gibberellic acid, which is produced from the fungus *Gibberella fujikuroi*, has been reported to exhibit profound growth-regulating properties when applied to plants. Rappaport found a 60-percent increase in fresh weight 10 days after an application of this material to the first expanded leaf of the young tomato plant (*1*). Kahn reported that gibberellic acid replaces the red light required for proper germination of lettuce seed (*2*). Harrington's investigations revealed that gibberellic acid induces flowering in nonvernalized endive plants (*3*).

The multitude of effects that gibberellic acid has induced in a number of plants led to our investigation, in which gibberellic acid was used as a chemical activator for breaking the rest period of the peach. The rest period, as referred to in this report, is a state of dormancy during which a plant will not produce visible growth even though environmental conditions are favorable. In order to overcome or "break" the rest period in peaches, a period of chilling is necessary. According to Weinberger, the chilling period necessary for activation of vegetative growth in the Elberta peach is 950 hours of temperature below 45°F (*4*).

Two-year-old Elberta peach trees which had "normally" dropped their leaves in the fall and had been exposed to temperatures below 45°F for a maximum of 164 hours were transplanted from the orchard to large cans and placed in a storage room kept at 65°F. United States weather records, taken in the area, were used in calculating the number of hours in which the temperature was below 45°F. Lights were on in the room from 8 A.M. to 5 P.M. daily, and the trees were watered as necessary.

On 23 February 1957, 95 days after the trees had been placed in the storage room, 14 trees were placed in the greenhouse for treatment with gibberellic acid (*5*). The following concentrations of gibberellic acid were used: 0, 50, 100, 200, 500, 1000, and 4000 ppm. Solutions of each concentration were sprayed on two trees. Fourteen days later, at the time of the second application, it was noted that a large percentage of the buds on the trees that had received the 1000- and 4000-ppm applications had grown and produced small green leaves. Trees that had been sprayed with the lower concentrations (0, 50, 100, 200, and 500 ppm) did not show any growth at that time. On 29 March, after the trees had received two applications of gibberellic acid (23 February and 8 March), the trees that had been sprayed with 1000 and 40000 ppm were growing rapidly. The trees that had received 200 and 500 ppm were growing some, but trees that had been sprayed with concentrations lower than 200 ppm were still dormant (Table 1). The growth response of trees that had received the same treatment was uniform.

In another experiment, three trees that had been exposed for 433 hours to temperatures below 45°F, nearly half of the number of hours necessary to break the rest period, were sprayed with 0, 100, and 200 ppm of gibberellic acid, respectively. The trees were sprayed four times at 10-day intervals. Four days after the first application it was noted that one or two buds on the tree that had received the 200 ppm spray were opening and exhibiting small leaves. Fifty days after the first application, the tree that had been treated with 200 ppm of gibberellic acid had an average of 14 inches of new terminal growth and large, "normal" green leaves. At the same time, buds on the tree that had been sprayed with 100 ppm had 3 to 4 inches of new growth, but there were still a few completely dormant buds. Two or three buds on the untreated control were just starting to "break" dormancy. Trees that have not been exposed to the necessary chilling period commonly have a few open terminal buds after a long period of favorable growing temperatures, but the growth is usually somewhat abnormal.

Table 1. Effect of gibberellic acid on the breaking of dormancy of buds of 2-year-old Elberta peach trees. The trees had been exposed to temperatures below 45°F for 164 hours before treatment. Data were recorded 29 March 1957, 36 days after the initial application of spray.

Gibberellic acid concn. (ppm)	Leaf buds growing		Av. growth per shoot (in.)
	(No.)	(%)	
0	0	0	0
50	0	0	0
100	0	0	0
200	17	40	0.25
500	17	50	0.5
1000	28	85	2
4000	37	98	4

Table 2. Effect of gibberellic acid on breaking the rest period in dormant peach seeds. Seeds received approximately one-half of normal stratification period before treatment. Data were recorded 16 days after the gibberellic acid treatment.

Gibberellic acid concn. (ppm)	Germination (%)
0	30
20	50
100	80
200	70
500	40
1000	30

Tests were also conducted with peach seed that had received 35 days of stratification—that is, the seed were placed in a moist medium at a temperature near freezing. The standard time for stratification of peach seed is between 60 and 100 days at 41°F, according to Kains and McQuesten (*6*). In this experiment ten seeds were soaked for 24 hours in each of the following concentrations of gibberellic acid: 0, 20, 100, 200, 500, and 1000 ppm. The seeds were then planted in a flat of sand, and after 16 days the percentage germination was recorded (Table 2).

The percentage germination of seed that had been soaked in 100- or 200-ppm concentrations of gibberellic acid was greater than that of seed that had been soaked in other concentrations. Concentrations higher than 200 ppm may have been toxic for optimum germination and growth. Twenty days after the treated seed had been planted, the plants were measured. There was little root growth and no top growth of the plants grown from seed that had been treated with concentrations in excess of 200 ppm. The root and top growth of plants grown from seed that had been soaked in 20-ppm concentration was greater than that of the untreated controls but smaller than that of plants grown from seed that had been soaked in the 100-ppm concentration. Plants grown from seed that had been soaked in the 100- and 200-ppm treatments averaged the same length and

weight, although there was considerable variation within a treatment. The plants grown from seed that had been treated with 100 ppm were much larger, averaging 48 percent more top growth than the untreated control plants. Three plants that had received the same treatment and that had the same amount of top growth were selected for comparison of their root systems. The roots of plants grown from seed that had been treated with 100- and 200-ppm concentrations of gibberellic acid were much larger than the roots of the untreated controls. Seed that had been soaked in the 100 ppm solutions produced plants with root systems of 56 percent greater length and 80 percent greater weight (on a fresh-weight basis) than did the untreated seed.

Gibberellic acid apparently activates the metabolic processes or nullifies the effect of an inhibitor of growth of young Elberta peach trees. Thus gibberellic acid "replaced" the cold requirement for the breaking of the rest period in the young trees. If mature trees responded similarly, without a detrimental effect on other plant processes, southern peach growers would be able to grow varieties that required a longer chilling period. There also exists the possibility of extending the peach industry further south to new areas. Further investigations of the effect of gibberellic acid on the biochemical processes may help in understanding the rest period of plants.

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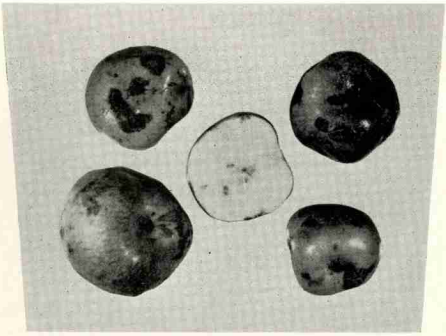
12 August 1957



The brown, corky areas on these apples are typical boron deficiency symptoms.

APPLES NEED BORON

David R. Walker

● MANY APPLE GROWERS recently have reaped far too big harvests of small, misshapen apples having brown, corky areas. Such fruit is not marketable, either fresh or processed. So objectionable are the brown, corky areas that they have caused hundreds of pounds of apple slices to be thrown away. A lack of boron is causing the trouble.

To determine the nature of the nutritional disorder, we checked 96 orchards in eight counties in 1955 and 1956. Red Delicious, Rome Beauty, Stayman and Golden Delicious varieties were sampled.

Chemical analyses of the leaf samples revealed boron shortages in many orchards. Twenty-nine per cent of the samples were deficient in boron or on the border line of deficiency (20 ppm or less).

Growers have realized the value of major fertilizer elements for many years. However, most have not been applying some of the other elements, such as boron, which are not as common and are needed in much smaller quantities.

Boron deficiency can be corrected fairly easily by applying small amounts of borax. In fact, since large amounts are harmful, it is recommended that applications *NOT* be made each year.

For a tree 10-15 years old, 8 ounces of borax every third year should be sufficient. This can be applied with other fertilizers during the fall or winter. Trees showing a deficiency might be given slightly higher rates the first year, but *under no circumstances should more than 30 pounds per acre be applied.* Too much boron will cause preharvest drops and a breakdown of fruit stored late in the season.

Weather has a great deal to do with the severity of the deficiency symptoms. They are much more prevalent during dry seasons, often reducing income considerably.

Since it's difficult to predict the weather, apple growers would be wise to apply boron this year if they have not done so the last two years. Boron applications are good insurance against small, misshapen, "corky" apples that won't sell.

Spare file

A Statistical Evaluation of a Growth Substance Bioassay Method Using Extracts of Dormant Peach Buds[1]

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The techniques for separating and identifying plant growth substances have changed rapidly during the past few years. Many plant materials have been studied for their adaptability as a bioassay test (7) and paper chromatography is now being used by many investigators to separate the growth substances. With the rapid advances, using these newer methods, no recent evaluation of the sources of variation in the new techniques has been made. Although Bentley's work (2) had a marked effect on subsequent methods no advantage has been taken of her discovery that "occasion" interacted with other effects investigated; giving rise to doubt about the wide use of within vial variation as an estimate of error.

In studying the occurrence of growth substances in peach flower buds, using paper chromatography and the wheat coleoptile straight growth bioassay, there appeared to be considerable variation between samples collected on the same day.

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Also, it was observed that extracted growth substances failed to lodge in the same positions on successive chromatographs. The purpose of this investigation was to learn if these sources of variation affected the variation of section means and if the true experimental error was correctly estimated by coleoptile variation of coleoptiles within vials.

Materials and Methods

Dormant Elberta peach flower buds collected January 29 and February 4, 1957, were used in this study. Immediately after each collection the buds were mixed thoroughly, divided into three gram samples, and stored at -12° C. until they were used.

The growth substances were extracted from the buds with methanol at 3° C. in the dark for one and three-fourths hours. The methanol extract was evaporated to dryness under reduced pressure and partially purified by a technique described by Nitsch (6) which he adapted from Jones and Reddick (5). The technique is briefly as follows: The methanol residue was taken up in acetonitrile and hexane (1:1) then shaken in a seperatory funnel. The hexane fraction, containing some fats and pigments, was discarded, and the acetonitrile fraction reduced to dryness. The residue was dissolved in ether and acidified with .001 N HCl in a seperatory funnel. The ether layer was dryed over sodium sulfate, reduced to a volume of approximately .3 ml. and placed in a syringe for application on a paper chromatogram.

The extract was placed equally at three separate locations on the base line of the chromatographic paper. Each location or spot of extract represented one gram fresh weight of buds. Descending chromatography on Whatman No. 1 paper was used throughout this study. The paper was equilibrated for at least 10 hours before the solvent (butanol-ammonia-water 10:1:1) was added. After the solvent had descended about 20 cm. the paper was removed from the chamber and dried in the

laboratory at room temperature using subdued light. After drying, the paper was cut into 17 equal sections including the original spot. For an untreated control a piece of paper the same size as the other sections was cut usually above the base line. One exception to this is mentioned in the results section.

The pieces of paper were then placed in small vials (12 x 60 mm.) with 1 ml. of a phosphate-citrate buffer (pH 5.0) and 2 per cent sucrose. Before the coleoptiles were added the vials were shaken for 30 minutes to elute from the paper any growth substances that may be present.

The wheat coleoptile straight growth test was used for the bioassay. The variety used was Atlas 66 which was selected on the basis of uniform growth after a preliminary investigation of twelve varieties which included a variety used by other investigators (7, 9). The method is briefly as follows: The seed was soaked in water for 2 hours, seeded in moist sawdust, and placed in an incubating chamber in a dark room at 24° C. and 90 per cent relative humidity. After 3 days, the wheat coleoptiles were ready for use. Coleoptiles 25-35 mm. long were selected. A 3 mm. section from the tip was removed and the next 4 mm. (52 micrometer divisions) was used for the bioassay. The primary leaf was not removed from the coleoptile. Cutting was done with a Van de Weij coleoptile microtome[1] as improved by Thimann and described by Nitsch (7). Cutting of the coleoptiles was done under a light similar to that described by Nitsch (7), consisting of two green fluorescent tubes wrapped with three layers each of amber and green cellulose acetate window shading. After cutting, the coleoptiles were soaked in distilled water for 3 hours; then selected at random and placed in vials containing 1 ml. of the buffer-sucrose mixture and the paper section from the chromatogram. The vials were placed on a wheel rotating at 1 rpm to reduce the amount of curvature

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[1]Coleoptile microtome obtained from E. L. Wilkie, Physics Department, Harvard University.

developed during the growth period. The coleoptiles were allowed to grow for 20 hours; after which they were removed from the wheel and measured with a binocular microscope equipped with an eye piece micrometer. Thirteen micrometer divisions were equal to one millimeter.

Results

Experiments were designed to detect various sources of variation together with their effect on experimental error, to determine the appropriate scale to be used for measurements, and to discover the optimum allocation of samples and coleoptiles in the experimental design.

Sources of Variation

In the first experiment, growth substances were extracted from four separate samples of buds collected the same day. Two of the samples were processed February 26 and the other two February 28. The chromatograms were developed and divided into sections as previously described. Ten coleoptiles per vial or section were used in the experiment. The statistical analysis (Table IA) showed a smaller mean square for coleoptiles, 23, than for experimental error, 347. This means that there are sources of variation, affecting the section means, other than the variation of coleoptiles in the vials. This finding recurred in every experiment.

In all experiments conducted there were highly significant differences among the sections. The substance or substances extracted from the peach buds located at Rf .53 inhibited the growth of the wheat coleoptiles. The occurrence and properties of the inhibitor are being studied and will be reported at a later time. Histograms showing the inhibition, as well as the variation of coleoptile growth between replications, are shown in figure 1.

Table I. The analysis of variance and mean length of a growth substance test involving four samples, two processed on each of two days.*

A. Analysis of variance

Source of variation	Degrees of Freedom	Mean Square
Samples		
Within Days	2	797
Between Days	1	5854
Sections (treatments)	17	3558
Experimental Error	51	347
Within Days** 34		335
Between Days** 17		383
Coleoptiles	648	23

For Error: $F = 347/23 = 15.1$, $P < 0.001$
For Sections: $F = 3558/347 = 10.3$ $P < 0.001$
For Samples Same Day: $F = 797/23 = 34.65$
For Samples Between Days: $F = 5854/23 = 254.5$

B. Mean Length of Coleoptiles in Micrometer Units (13 units = 1mm.)

Sample	Date Processed 2/26/57	2/28/57
1	80.5	86.9
2	78.3	83.3
Average	79.4	85.1

* Eighteen sections of the chromatograph per sample were bioassayed with ten coleoptiles per section.

** Components of experimental error. See text.

The large mean square between days as compared to that within days has only one obvious explanation, the different growth potential of coleoptiles in trays prepared on different occasions. This coincides with Bentley's findings. The contrast recurred in a second set of samples chromatographed on three separate days. But in both experiments the components for experimental error (within and between days) were substantially the same. Though the coleoptile growth potential is different between days, the coleoptiles used for a given treatment grew the same relative amount from day to day when comparing it with other treatments. This is indicated by the similarity of the within and between days experimental error of 335 and 383 respectively in table I.

To investigate more fully the sources of variation in experimental error, which is the failure of similar sections of paper to differ equally, another experiment was designed. The object was to measure the growth substances from two separate samples with two aliquots from each sample. The paper from each aliquot was divided in half longitudinally for half section comparisons. This provided measurements of the variation between samples, between aliquots within a sample, among sections, and among halves of sections.

The mean squares and estimates of components of variance for this experiment are indicated in Table II. (A component of variance measures the variation attributable to only one particular source.) It is to be observed again that experimental error has a large component of variance which is separate from that of the coleoptiles and from those of the contributing interactions. The only interaction contributing materially to error is that between halves and sections, due apparently to irregularities in the shape of the spots in the paper.

To examine the variations in paper, known concentrations of indoleacetic acid (IAA) and indolebutyric acid (IBA) were freshly prepared and chromatographed

Figure 1. Diagrams showing the lengths of wheat coleoptiles treated ~~from~~ with eluates from the chromatogram. The original length of the Coleoptiles was 52 units. The dashed lines indicate the lengths of untreated coleoptiles. The vertical bar on the lower histogram shows the 95% confidence interval.

Table II. The analysis of variance of a growth substance test involving two samples, two aliquots per sample, 18 chromatographic sections per aliquot, each section cut in two pieces. Five coleoptiles per vial.

Source of Variation	Degrees of Freedom	Mean Square	Estimate of Component of Variance
Samples	1	534	
Sections (treatments)	17	7507	
Experimental Error	17	1117	53
Aliquots in Sample	2	220	0
Aliquots x Section in Sample	34	62	0
Halves of same Aliquot	4	312	3
Halves x section of same Aliquot	68	89	14
Coleoptiles	576	21	21

three separate times. The chromatographic chamber was in a constant temperature room maintained at 26° C. Each chromatogram was divided into seventeen equal sections and sprayed with the Gordon Weber (4) reagent. The results showed that these substances did not always occur in the same sections or have the same Rf values. In some chromatograms IAA was detected in sections 6-9 (Rf .38) in another 7-10 (Rf .42) and another 8-11 (Rf .51). The spot generally covered the same total area but varied in its position. IBA occurred in sections 11-13 (Rf . 67), 12-14 (Rf .71) and 14-16 (Rf .82) a variation of 3 sections.

This means that known substances chromatographed on different sheets of paper and different days may not always occur in the same position. This failure of repeatability doubtless occurs with unknown as well as known substances. It may well be a major contributor to experimental error. It follows that replication of samples is essential in order to estimate correctly the true experimental error.

The appropriate scale of measurements

In some growth substance literature (1, 3, 8) the data have been converted to percentages of control. This makes it seem easy to compare results of different treatments in the same experiment or of the same treatment in different experiments. Difficulties arise when standard errors are needed for tests of significance. Since both section mean and control mean are variable, the standard error of their ratio is a somewhat complicated expression which varies from one section mean to another. Moreover the distribution of the percentages is not normal. Both facts raise doubts about application of the ordinary t and F tests, including confidence intervals.

If it were necessary to use percentages, ways for avoiding the difficulties would have to be found. But the results of several experiments indicate that use of the original growth increments gives valid estimates and tests as well as

convenient methods of comparing means. These results are of two kinds.

First, there were three experiments in which all coleoptiles had essentially the same treatment. In each experiment the coleoptiles were incubated for the normal time (20 hours) in the buffer-sucrose solution as untreated controls. The increases in length of these coleoptiles followed approximately normal distribution curves (Figure 2). Data distributed like these are appropriately treated by the ordinary statistical methods following additive models.

A second kind of evidence for the usual additive methods is based on tests of additivity in analysis of variance, using Tukey's test (11). This test was applied to five experiments with F equal to 0.57, 0.05, 0.002, 4.5 and 0.0005. Non-additivity was negligibly small in four of the experiments and non-significant in the fifth. The evidence is clearly in favor of additivity. This is fortunate because additivity is assumed in making the ordinary tests of significance by *F* or t.

It follows that in presenting growth substance data and in analyzing them statistically the actual growth units should be used. Transforming the data to percentages of control introduces unnecessary complications.

Optimum Allocation of Samples and Coleoptiles

True replication includes all sources of variation contributing to the variation of means. Thus as replications one should use individual samples carried separately throughout the bioassay procedure rather than coleoptiles treated the same within one vial.

The number of replications one should use depends on the precision desired and the funds available for the experiments. The data above suggest that since the coleoptile variance is small there is little advantage in using ten coleoptiles per vial as most investigators have done. If the same number of coleoptiles were used with more true replications (samples), the variance of the mean and the

Figure 2. Total growth of coleoptiles treated similarly on three days. The original length of the coleoptiles was 52 units.

confidence intervals might be much smaller.

The following experiment furnishes an example of this. Four samples each chromatographed and divided into eighteen sections with only two coleoptiles per section were used. The analysis of this experiment, shown in Table III, had 33 as an estimate of the coleoptile error component and 89 as that of the experimental error. If a new experiment with n_2 coleoptiles and n_1 samples were conducted, the components of variance being unchanged, the experimental error would be estimated as $33 + 89n_2$. A section mean, based on n_1n_2 observations, would then have the variance, $\frac{33 + 89n_2}{n_1n_2}$ or $\frac{33}{n_1n_2} + \frac{89}{n_1}$.

It is clear that this variance, measuring inversely the sensitivity of the experiment, is little affected by n_2 (number of coleoptiles per vial), but is decreased in direct proportion to n_1 (number of samples). It is more effective to control the large component of error by increasing n_1 than to bother with the small component by increasing n_2.

Table IV shows that by using the same total number of coleoptiles but having more samples and less coleoptiles per vial the sensitivity is greatly increased. For example, substituting in the above formula, if one uses 8 samples ($n_1 = 8$) and only one coleoptile per vial ($n_2 = 1$) the variance of the mean can be reduced from 93.1 to 15.2.

So far nothing has been said about the costs of the experiments specified in Table IV. Instead of basing decisions on only the variance of the mean, it is more realistic to consider what combination of samples and coleoptiles per vial will produce the smallest variance per unit cost. This depends partly on the relative costs of coleoptiles and samples.

In terms of time, the cost of processing coleoptiles (soaking and planting seed, then cutting and finally measuring coleoptiles) was estimated as $c_2 = 1.5$ minutes each. The additional cost of a section per sample (collecting buds,

Table III. The analysis of variance of a growth substance test involving 4 samples, 18 sections, and 2 coleoptiles per section.

Source of Variation	Degrees of Freedom	Mean Square	Estimated Component
Sample	3	292	
Sections	17	712	
Error	51	211	$\frac{211-33}{2} = 89$
Coleoptiles	72	33	33

Table IV. Estimate of the variance of mean based on number of samples and number of coleoptiles per vial.

Example	Number of Samples n_1	Number of Coleoptiles Per Vial n_2	Coleoptiles Per Test	Variance of Mean
1	1	8	8	93.1
2	1	10	10	92.3
3	2	4	8	48.6
4	4	2	8	26.4
5	4	4	16	24.3
6	8	1	8	15.2

purifying, chromatographing, handling vials, etc.) was approximately $c_1 = 2\ 1/2$ minutes. These values, along with $s_1^2 = 89$ and $s_2^2 = 33$, may be substituted in a formula to determine the number of coleoptiles per vial (n_2) to produce the least variance for a specified total cost (10).

$$n_2 = \sqrt{\frac{c_1}{c_2} \cdot \frac{s_2^2}{s_1^2}}$$

This gives

$$n_2 = \sqrt{\frac{2.5}{1.5} \cdot \frac{33}{89}} = 1.43 \text{ coleoptiles per vial}$$

The corresponding number of samples is $n_1 = 4.74$ with resulting variance of the mean, $V\bar{x} = 23.7$. Practically, either one or two coleoptiles per vial may be used. The corresponding numbers of samples n_1 and variance $V\bar{x}$ are:

one coleoptile per vial, $n_1 = 5$. $V\bar{x} = 24.4$

two coleoptiles per vial, $n_1 = 4$. $V\bar{x} = 26.3$

Despite the slightly greater efficiency with one coleoptile per vial (using 5 samples) many investigators may feel safer with two (using 4 samples).

The number of samples may be varied at will depending on the precision required and on the available time and material.

Summary

Methanol extracts of dormant peach buds were analyzed for possible growth promoting and inhibiting substances. Paper chromatography techniques and the wheat coleoptile straight growth test were used for separation and measuring respectively of the growth substances present. A growth inhibitor (Rf .53) occurred in all of the peach bud samples and is being investigated further. Results of the statistical study are summarized below:

1. Replications of coleoptiles treated similarly is an underestimate of the experimental error; true replication is by use of separate samples including all sources of variation.
2. The largest component of experimental error was the failure of known and unknown growth substances chromatographed always to appear in the same section.
3. Growth of coleoptiles follows approximately a normal distribution curve indicating additivity. This is confirmed by a statistical test of additivity. Therefore, ordinary statistical techniques can be used directly without transforming the data. Changing the growths to percentages of control introduces unnecessary complications.
4. It was shown that the variance of the mean is decreased more by increasing the number of replications (samples) than by increasing the number of coleoptiles per vial.
5. For experiments of the type described, 1 or 2 coleoptiles per section are indicated as furnishing the greatest information per hour spent.

The authors wish to express their appreciation to Dr. D. D. Mason of the Experimental Statistics Department and Dr. Loyd E. Powell, Jr. of the New York Agricultural Experiment Station for the guidance received from them in the early stages of this investigation.

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The Use of Chelated Magnesium and Magnesium Sulfate in Correcting Magnesium Deficiency in Apple Orchards[1]

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Magnesium deficiency in northeastern United States apple orchards has become a serious problem. The use of elemental sulfur sprays for the control of apple scab has contributed to the severity of the problem. Many orchard soils have been considerably acidified, resulting in heavy losses of basic cations such as magnesium from the soil. Dolomitic limestone has been used extensively for the control of this deficiency, but control is seldom obtained before the third year after application. Magnesium sulfate foliar sprays have been used as a temporary control (1, 3, 4, 9), and under some conditions have been fairly successful in reducing magnesium deficiency symptoms. On occasions, however, the recovery has not been as effective as desired. Recently, certain deficiencies have shown a rapid control response when the deficient elements were applied to the soil in an organically chelated form. Chelated iron in particular has been reported to be successful in reducing iron chlorosis in short periods of time on citrus (6, 7, 10) and ornamentals (13). In this study foliar and soil applications of chelated magnesium (ethylenediamine tetra acetic acid which is 5.5 per cent metallic magnesium) and magnesium sulfate (epsom salt) were compared in field trials during 1953 to study their effect on control of magnesium deficiency. The responses to magnesium sulfate spray applications applied at different times was studied in 1954.

Materials and Methods

Three apple orchards with trees showing magnesium deficiency symptoms were selected the fall before treatments were applied. Trees given the chelated magnesium received much less magnesium than those receiving magnesium sulfate. A maximum of 2.70 pounds of magnesium chelate, (67.4 grams magnesium) was applied per tree. This was considerably larger than the rates of chelated iron applications used by Stewart and Leonard who controlled iron deficiency symptoms in citrus with as little as 10 grams of chelated iron per tree. Others (12, 13) have found a few ounces of iron chelate very beneficial in reducing iron chlorosis.

Orchard I was a block of 25-year-old McIntosh trees growing in a moderately well-drained Cossayuna gravelly loam soil near New Paltz, New York. There were ten treatments replicated six times in a randomized block design with two trees per plot (Table 1). Chelated magnesium was applied to the soil (treatments C and D) April 2, 1953. The foliar sprays were applied June 18, 27 and July 5, 1953. Trees receiving two foliar sprays were treated June 18 and 27, 1953. Treatment E consisted of rewetting the foliage with a small amount

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Table 1.—Magnesium content (per cent dry weight) and visual deficiency symptom rating of McIntosh apple leaves in Orchard I in 1953.

Treatment	Number of foliar sprays applied	Leaf magnesium			Visual rating*
		June 17	Aug. 17	Sept. 18	
A. Control untreated		.19	.16	.12	4.0
B. 15 lbs. $MgSO_4$, spring 1952		.19	.20	.17	2.3
Soil treatments					
C. ½ lb. Chelated Mg		.17	.17	.13	3.8
D. 1½ lb. Chelated Mg		.18	.15	.12	4.3
Foliar sprays					
E. 15 lbs./100 gallons $MgSO_4$+wetting at noon, 5 pm and 8 pm	2	.16	.17	.15	3.2
F. 15 lbs. $MgSO_4$+5 lbs. Urea/100 gallons	2	.19	.23	.20	0.8
G. 15 lbs./100 gallons $MgSO_4$	3	.19	.22	.17	1.9
H. 15 lbs./100 gallons $MgSO_4$	2	.20	.22	.19	1.8
I. 1½, 2 and 2 lbs./100 gallons Chelated Mg	3	.19	.19	.15	3.3
J. 1½, 2 and 2 lbs./100 gallons Chelated Mg +2½, 2½ and 5 lbs./100 gallons Urea	3	.19	.20	.17	2.5
LSD .05		.03	.04	.05	2.05
.01		.04	.05	.07	2.74

*Visual ratings were recorded September 16, 1953. The values are an average of 12 trees rated from 0 to 10 (not visible to very severe respectively) for magnesium deficiency symptoms.

of water to maintain a high humidity for absorption. Approximately 18 gallons of spray mixture were applied per tree at each application to the trees in the three orchards receiving the foliar sprays.

Orchard II was a block of 20-year-old McIntosh apple trees growing on a well-drained Dunkirk fine sandy loam located near Ontario, New York. Four treatments were replicated four times in this orchard. Foliar spray treatments of magnesium sulfate and chelated magnesium were compared with chelated magnesium sprayed on the soil underneath the trees and with an untreated control. Sprays were applied on June 8, 22, and July 7, 1953 to each tree receiving the foliar spray treatments (treatments A and B). Trees receiving chelated magnesium ground sprays were treated June 22, 1953 (Table 2).

Table 2.—Magnesium content (per cent dry weight) of McIntosh apple leaves in Orchard II in 1953.

Treatment	Leaf magnesium		
	June 8	Aug. 11	Sept. 23
A. 15 lbs. $MgSO_4$/100 gallons foliar spray	.23	.43	.41
B. 1½ lbs. Chelated Mg/100 gallons foliar spray	.24	.34	.32
C. 15 lbs./100 gallons Chelated Mg sprayed* on soil around tree	(a)	.33	.28
D. Untreated control	.25	.31	.25
LSD .05	.03	.05	.07
.01	.05	.07	.09

*Treatments applied June 22, 1953 and samples not compared until August 11.

In 1954 a third orchard of 20-year-old apple trees located on a very sandy soil of the Alton series near Olcott, New York, was used in studying the effect of time of application of magnesium sulfate foliar sprays. Visual ratings of magnesium deficiency symptoms were recorded for each tree in the orchard in the fall of 1953. Trees with the most severe symptoms were selected in 1953 and used in 1954. The seven foliar spray treatments and the untreated control were

replicated eight times. Two replications were on Jonathan trees and the other six were on Red Delicious. The treatments consisted of early (shortly following petal fall in June) and mid-summer (July) sprays of magnesium sulfate with and without urea. All treated trees received three spray applications. The early season foliar sprays were applied June 2, 16 and 24. Mid-summer foliar sprays were applied July 2, 8 and 15, 1954 (Table 3).

Table 3.—Magnesium content (per cent dry weight) of apple leaves in Orchard III in 1954.

Treatment	Month applied	Leaf magnesium		
		June 15	Aug. 3	Sept. 16
A. Control, untreated		.21	.29	.21
Foliar sprays				
B. 15 lbs. $MgSO_4$+5 lbs. Urea/100 gallons	June	.22	.27	.33
C. 15 lbs. $MgSO_4$+5 lbs. Urea/100 gallons	July	.21	.37	.49
D. 15 lbs. $MgSO_4$/100	June	.22	.33	.33
E. 15 lbs. $MgSO_4$/100	July	.21	.34	.47
F. 20 lbs. $MgSO_4$+7 lbs. Urea/100 gallons	July	.20	.39	.50
G. 5 lbs. Urea/100 gallons	June	.21	.24	.21
H. 5 lbs. Urea/100 gallons	July	.20	.24	.23
LSD .05		N.S.	.09	.05
.01		—	.12	.06

Leaf samples were collected at three sampling dates in June, August and September in 1953 and 1954. Thirty midshoot leaves were collected at random around the periphery of each tree at each sampling date. Individual samples for each plot were washed, dried and ground before they were analyzed. Leaf magnesium and nitrogen were determined on all samples. Leaf potassium and calcium determinations were also made on the samples collected in Orchard I. Magnesium was determined by the method of Drosdoff and Nearpass (5). Nitrogen was determined by the Kjeldahl procedure, and potassium and calcium using a Perkin-Elmer flame photometer essentially with the method of Toth *et al.* (11).

Soil samples were collected from each of the orchards before and after treatment. The soil samples were analyzed for magnesium, calcium, iron, manganese, aluminum, and pH. Differences between treatments were in general not significant and are not discussed in detail.

Results

I. Chelated Magnesium vs. Magnesium Sulfate Applications.

Orchard I (Table 1):—Leaf samples taken in June of 1953 were collected before the foliar sprays were applied. All trees contained approximately the same amount of magnesium, except treatment E, which was at a slightly lower level. The samples collected in August from trees receiving the foliar magnesium sulfate sprays, with the exception of treatment E (two sprays of magnesium sulfate plus wetting), showed an increase in leaf magnesium when compared with the untreated control. The trees receiving foliar sprays of chelated magnesium tended to have more magnesium in their leaves than trees receiving the soil applications of chelated magnesium or than the untreated control. Trees receiving foliar sprays of mag-

nesium sulfate tended to contain more leaf magnesium than did trees receiving chelated magnesium, although the differences were not significant in this orchard as they were in Orchard II. Results of the September sampling showed the same relationship as did the August samples except that the magnesium level had decreased slightly in all treatments. In September the trees were rated for magnesium deficiency symptoms. Trees exhibiting deficiency symptoms contained less leaf magnesium than did those not showing symptoms. Leaves containing .20 per cent magnesium showed symptoms only on a few branches. This is in agreement with Boynton (2) who reported magnesium deficiency symptoms rarely occur on mature apple trees containing .25 per cent magnesium but are likely to appear on trees which contain less than .15 per cent magnesium. Leaves between these two levels may exhibit magnesium deficiency symptoms depending on other conditions.

The concentrations of potassium and calcium found in the leaves in Orchard I in 1953 did not show any differences as a result of treatment, and hence are not given in detail here.

Orchard II (Table 2):—Leaf samples taken in June were collected before the foliar sprays were applied. All samples contained about the same concentration of magnesium at that time. By August the trees receiving the foliar sprays of magnesium sulfate had significantly (.01 level) more magnesium in their leaves than did the trees receiving the chelated magnesium as a foliar or as a ground spray. In fact, the trees receiving chelated magnesium (foliar and soil) contained only slightly more leaf magnesium than did the untreated control. The September samples showed about the same relationship as did the August samples, except that the trees receiving the foliar sprays of chelated magnesium tended to have more magnesium in their leaves than did the untreated control. These data are summarized in Table 2. Magnesium deficiency symptoms were not apparent in 1953 in this orchard—hence visual ratings were not recorded.

II. The Effect of Time of Application.

Orchard III (Table 3):—Leaf samples taken in June were again collected before the foliar sprays were applied. All samples contained the same amount of magnesium at that time. By August the samples from trees receiving magnesium sulfate sprays were at a higher level in leaf magnesium, except treatment B (three sprays of magnesium sulfate plus urea applied in June) than were the samples from trees not receiving the magnesium sulfate foliar sprays. Samples collected in September from trees receiving the foliar sprays of magnesium sulfate all contained significantly (.01 level) more magnesium than did the other treatment. Those from trees receiving only urea contained about the same amount of magnesium as did the untreated control. Samples receiving only magnesium sulfate contained nearly the same amount of magnesium in their leaves as trees receiving magnesium sulfate in combination with urea. Samples receiving the sprays during the first two weeks in July contained

significantly (.01 level) more magnesium in their leaves than did those receiving the sprays in June. This conceivably could have been a dilution effect since terminal growth was not completed when the June sprays were applied, although Rogers and Batjer (8), measuring seasonal changes of some essential elements in untreated apple leaves, found no pronounced changes in the magnesium level during the season. Magnesium deficiency symptoms were not present in the orchard during 1954. Climatic differences apparently have considerable influence on symptom expression when trees are near the critical level. The leaf analysis data showing these relationships are given in Table 3.

Considerable marginal necrosis occurred by the first part of August on the leaves of trees sprayed with the higher concentration of magnesium sulfate and urea (treatment F) in the western New York area. This treatment applied in the Hudson Valley showed no foliar injury during the same season. The difference in necrosis may have resulted from climatic differences. During the summer of 1954 the western New York area was hot and had little precipitation while the Hudson Valley received a larger amount of precipitation.

Summary

In this study chelated magnesium, applied as foliar sprays or as soil applications, was not as effective in increasing leaf magnesium in apple trees as foliar sprays of magnesium sulfate.

Trees sprayed with magnesium sulfate in early to mid-July contained significantly (.01 level) more magnesium in their leaves in September than did trees similarly treated in June shortly after bloom.

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Notes on the Fertilization of Apple Orchards in North Carolina

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Qbservations and leaf analysis studies have shown that many orchards are low in boron and nitrogen. The following information may be helpful in correcting these deficiencies.

A. Boron Deficiency

1. Symptoms - Brown corky dead cell spots in fruit. The surface of the fruit may be corky, russetted, misshapen and dwarfed.

2. Control - Soil and foliage applications of boron have proved successful in controlling the deficiency. Soil applications are not as effective the first year, but when treatments are not repeated, soil applications are more effective the second and third years than foliage treatments.

   a. Material - Borax for soil and a finer powder form such as Polybor-2 for foliage applications.

   b. Time of application - The soil application should be made at least one month before bloom every third year. Fall and spring applications are equally effective according to our present information. Two foliar spray applications just after petal fall at a two week interval has also been effective.

   c. Method of Soil Application - A narrow band under the drips of the branches is preferred to broadcasting.

   d. Cost of Soil Application - Borax is around $5.00 per 100 pounds, this means, using 1/2 pound per tree for figuring, that it only costs 2 1/2 cents per tree every three years.

   e. Amount to apply - For a foliar spray use 1 to 2 pounds per 100 gallons. For soil applications the following tables will serve as a guide and should not be exceeded for fear of injury to trees.

[1]Rates of Borax Applied to Soil Every Third Year for Different Size Trees*

Age of Tree	Trunk diameter 1 foot above ground	Amount borax for ring application on soil
	Inches	Ounces
0-3	1/2 - 2 1/2	None
4-6	3 1/2	2
7-9	5	4
10-12	7	6
13-15	10	8
16-24	14	8-12
25 and more	15 and more	12-16

*The size of a tree is more dependable than the age for determining the amount of borax needed.

[1]Table from Cornell bulletin 428.

Rates of Borax Applied to Soil Every Third Year for Different Bearing Capacities of Trees[1]

Bearing capacity of tree	Ounces of borax every third year
Less than 10 bushels	4-6
10-20 bushels	6-8
More than 20 bushels	8-16

[1]Cornell bulletin 789.

Less information is known about foliar sprays than soil applications. If you are interested in foliar sprays and the material is not available, contact the author for a trial sample of Polybor-2.

B. Nitrogen Deficiency

1. Symptoms - Short, stubby terminal growth less than 8-10", pale green leaves, light fruit set and light yield.

2. Control

a. Material - There are many sources of nitrogen available. Ammonium nitrate, nitrate of soda, calnitro, ANL or urea are a few of the more commonly used ones in North Carolina. Those mentioned above are all applied to the soil except urea which is generally applied as a foliar spray. For a given amount of actual nitrogen there is little difference in response between carriers.

b. Time of application - Nitrogen should be applied at least one month before bloom. The ammonia form of nitrogen is slightly slower acting and requires one to two weeks earlier application then the nitrate form. Applying in early spring insures against leaching by winter rains, although fall and winter application has proved satisfactory for many growers. The amount you apply seems more important than the time of application.

c. Method of Soil Application - Broadcast evenly underneath the drips of the branches.

d. Method of Spray Application - Urea sprays have been found satisfactory as a supplemental nitrogen source. If the foliage is pale green in the spring a urea spray will act rapidly in greening the foliage. One or two sprays applied at the rate of 5 pounds per 100 gallons in the petal fall first or second cover spray is the most satisfactory time of application. These sprays should not be applied after mid-June or they will delay the fruit coloring.

e. Amount to Apply - The following table can be used as guide in your nitrogen fertilization program.

Rates of Nitrogen Application for Mature Apple Trees

Bearing capacity of tree	Amount Per Tree			
	Actual Nitrogen	Ammonium Nitrate (33% N)	Sodium Nitrate (16% N)	ANL or Calnitro (20.5% N)
		pounds	pounds	pounds
Less than 10	.5-1.0	1.5-3.0	3-6	2.5-5.0
10-20 bushels	1.0-1.3	3.0-4.0	6-8	5.0-6.5
More than 20	1.3-2.0	4.0-6.0	8-12	6.5-10.0

Some growers have applied higher rates of nitrogen with success. The above rates are suggested until more is known on this subject.

C. Fertilizer for Sod

Phosphorous and potassium are not as important for the apple tree itself as they are in maintaining a good cover crop or grass sod. The ground cover helps prevent erosion and builds up organic matter. Broadcast throughout orchard 200 pounds per acre of 8-8-8 every two or three years to the cover and keep well mowed during summer to prevent competition with trees for water and nutrients.

THE NUTRIENT ELEMENT STATUS OF GOLDEN DELICIOUS APPLE LEAVES COLLECTED IN ALEXANDER COUNTY, JULY 22, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Ben Blair	G-151	2.27	.14	1.8	.97	.28	81	24	30	8.8	51	10.0
J. C. Fortner	G-153	2.51	.13	1.8	1.02	.34	68	24	30	5.4	46	11.5
Fred Johnson	G-154	1.71	.18	2.0	1.11	.32	73	26	32	5.8	47	6.0
Howard Gryder	G-155	2.04	.16	1.8	1.30	.38	124	26	33	50.0	54	7.5
L. W. Davis	G-156	2.04	.15	1.5	1.36	.37	109	16	15	5.2	56	5.0
Lonnie Scott	G-158	2.07	.14	1.4	1.45	.30	98	28	38	6.5	108	5.0
County Average		2.11	.15	1.7	1.20	.33	92	24	30	13.6	60	7.5

THE NUTRIENT ELEMENT STATUS OF STAYMAN APPLE LEAVES COLLECTED IN ALEXANDER COUNTY, JULY 22, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Ben Blair	S-151	1.82	.13	1.3	1.06	.29	52	14	14	5.3	39	
C. D. Poole	S-152	1.76	.15	1.4	1.16	.29	59	18	19	15.5	40	
J. C. Fortner	S-153	1.85	.14	1.2	1.31	.37	70	20	20	6.5	45	9.5
Fred Johnson	S-154	1.68	.15	1.6	1.26	.31	98	22	24	6.7	37	13.8
Howard Gryder	S-155	2.02	.17	1.2	1.71	.48	107	19	17	6.7	47	
L. W. Davis	S-156	1.57	.16	1.6	1.58	.26	103	20	19	5.9	32	5.0
Garfield Childers	S-157	1.79	.14	1.5	1.33	.35	76	18	16	6.6	41	
Lonnie Scott	S-158	1.99	.13	1.3	1.58	.37	93	25	26	7.5	63	8.3
County Average		1.81	.15	1.4	1.37	.34	82	20	19	7.6	43	9.2

THE NUTRIENT ELEMENT STATUS OF DELICIOUS APPLE LEAVES COLLECTED IN ALEXANDER COUNTY, JULY 22, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Ben Blair	D-151	2.07	.13	1.7	.88	.30	54	15	15	6.0	44	11.5
C. D. Poole	D-152	1.79	.15	1.6	1.00	.29	54	18	18	4.3	36	9.5
J. C. Fortner	D-153	1.71	.12	1.2	.81	.29	62	16	16	5.6	37	14.5
Fred Johnson	D-154	1.76	.13	1.6	.86	.29	80	19	20	5.1	36	11.8
Howard Gryder	D-155	1.96	.15	1.1	1.29	.42	103	18	18	50.0	36	10.7
L. W. Davis	D-156	1.62	.18	1.5	1.10	.26	84	24	30	5.8	40	10.5
Garfield Childers	D-157	1.82	.13	1.5	.77	.27	65	16	17	5.4	46	13.0
Lonnie Scott	D-158	1.88	.13	1.6	.61	.27	91	15	15	13.7	42	50.2
County Average		1.83	.14	1.5	.92	.30	74	18	19	12.0	40	16.5

Status

The NUTRIENT ELEMENT/ OF DELICIOUS APPLE LEAVES COLLECTED IN HAYWOOD COUNTY, JULY 20, 1955.

D. R. Walker

Orchard Owner	Per Cent Dry Weight					Parts Per Million					
	N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Pink Francis	2.04	.17	1.8	1.41	.28	67	21	26	7.5	46	8.0
R. H. Boone	1.99	.21	1.8	1.47	.24	66	19	22	6.0	46	9.5
James Frady	2.24	.16	1.7	1.18	.22	85	17	18	4.9	48	6.0
H. H. Eavenson	2.18	.13	1.5	.97	.24	113	18	19	4.7	39	9.0
Bolling Hall	2.02	.15	1.6	1.06	.28	67	17	18	5.4	52	7.8
Richard Barber	2.07	.15	1.6	.92	.26	68	16	16	5.2	52	11.0
L. A. Cogburn	1.68	.22	1.7	1.06	.24	47	19	21	6.2	42	11.5
W. T. Gibbs	1.68	.22	1.8	.89	.25	59	14	14	6.6	38	8.5
Ira Cogburn	2.02	.17	1.6	1.12	.28	58	20	22	6.2	51	12.2
Z. L. Massey	2.13	.14	1.7	1.07	.25	68	14	12	5.0	48	19.0
County Average	2.01	.17	1.7	1.12	.25	70	18	19	5.8	46	10.3

THE NUTRIENT ELEMENT STATUS OF GOLDEN DELICIOUS APPLE LEAVES COLLECTED IN HAYWOOD COUNTY, JULY 20, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
R. H. Boone	G-51	1.96	.23	2.2	1.60	.24	67	17	15	6.3	53	
H. H. Eavenson	G-53	2.04	.16	1.3	1.34	.39	110	21	20	6.1	74	
Bolling Hall	G-54	2.21	.12	1.4	1.21	.29	72	15	12	5.1	60	27.8
Richard Barber	G-55	2.04	.16	2.0	1.29	.22	62	15	13	5.4	66	
L. A. Cogburn	G-56	1.74	.20	2.0	1.19	.23	48	19	18	3.9	36	
W. T. Gibbs	G-57	1.62	.20	2.0	1.21	.26	51	17	14	12.9	32	
Ira Cogburn	G-58	1.88	.16	1.8	1.69	.36	92	25	38	14.5	97	10.5
Z. L. Massey	G-59	2.07	.18	2.0	1.26	.31	106	20	22	7.2	70	53.5
County Average		1.95	.18	1.8	1.35	.29	76	19	19	7.7	55	30.6

THE NUTRIENT ELEMENT STATUS OF STAYMAN APPLE LEAVES COLLECTED IN HAYWOOD COUNTY, JULY 20, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Pink Francis	S-50	2.16	.17	1.6	1.42	.27	72	17	17	5.0	53	7.8
R. H. Boone	S-51	1.85	.24	1.9	2.11	.30	80	21	25	6.2	48	11.3
James Frady	S-52	2.13	.16	1.5	1.34	.24	84	17	16	7.0	53	19.5
H. H. Eavenson	S-53	2.02	.12	1.2	.98	.29	119	18	20	4.0	49	
Bolling Hall	S-54	1.90	.15	1.4	.94	.22	53	21	24	5.1	38	18.8
Richard Barber	S-55	1.96	.12	1.5	1.28	.20	77	15	14	4.8	50	8.8
L. A. Cogburn	S-56	1.74	.23	1.4	1.39	.26	58	17	17	8.0	39	8.3
W. T. Gibbs	S-57	1.54	.18	1.4	1.12	.24	52	11	9	22.9	24	13.8
Ira Cogburn	S-58	1.88	.17	1.5	1.22	.26	49	18	20	4.9	39	7.8
Z. L. Massey	S-59	1.74	.13	1.4	1.09	.22	72	15	16	6.2	37	
County Average		1.89	.17	1.5	1.29	.25	72	17	18	7.4	43	12.0

THE NUTRIENT ELEMENT STATUS OF DELICIOUS APPLE LEAVES COLLECTED IN HENDERSON COUNTY, JULY 19, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Bert Lytle	D-1	2.13	.14	1.8	1.10	.28	79	23	30	5.1	46	9.3
S. Schneider	D-2	2.21	.16	1.9	1.00	.32	72	22	27	10.0	48	12.0
W. H. Davis	D-3	2.07	.15	2.1	.87	.26	80	19	22	5.9	56	14.3
M. A. Paxton	D-4	2.18	.14	1.8	1.20	.30	68	17	31	5.4	50	7.8
Frank L. Fitzsimmons	D-5	1.93	.15	2.1	1.20	.28	74	22	26	5.6	53	13.0
Nun Henderson	D-6	2.27	.14	1.7	1.12	.28	82	17	18	5.6	49	13.5
Glen Williams	D-7	2.41	.16	1.8	1.24	.28	91	20	23	6.6	59	14.0
Grady Hill	D-8	2.18	.13	1.6	1.05	.30	78	15	14	13.2	63	10.5
Eulis Staton	D-9	2.30	.14	1.7	1.19	.40	85	20	24	6.0	60	11.5
L. A. Enloe	D-10	2.38	.15	1.6	1.13	.28	58	20	23	6.4	43	17.5
W. J. Enloe	D-11	2.21	.14	2.0	1.02	.24	65	26	35	9.9	43	14.8
P. T. Dalton	D-12	2.21	.14	1.6	1.05	.30	61	18	19	5.9	60	8.0
William E. Dalton	D-13	2.18	.15	1.8	1.13	.23	59	20	23	12.2	41	7.8
County Average		2.21	.15	1.8	1.10	.29	73	20	24	7.6	51	11.8

THE NUTRIENT ELEMENT STATUS OF GOLDEN DELICIOUS APPLE LEAVES COLLECTED IN HENDERSON COUNTY, JULY 19, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Bert Lytle	G-1	2.13	.13	1.8	1.30	.24	71	25	27	8.5	52	
S. Schneider	G-2	1.88	.14	1.7	1.22	.27	63	22	22	6.5	30	
M. A. Paxton	G-3	1.74	.13	1.8	1.22	.27	48	24	26	3.9	44	
Frank L. Fitzsimmons	G-4	1.90	.14	1.8	1.18	.21	49	18	17	4.1	47	
Nun Henderson	G-5	2.13	.13	1.6	1.03	.25	74	17	15	5.5	36	12.8
Glenn Williams	G-6	2.41	.16	1.7	1.44	.32	80	20	19	6.5	58	
Grady Hill	G-7	2.13	.13	2.0	1.10	.29	64	17	15	50.0	58	
Eulis Staton	G-8	2.38	.15	1.5	1.19	.37	70	21	23	5.8	61	
L. A. Enloe	G-9	2.24	.15	1.7	1.05	.28	61	21	20	6.4	52	14.3
W. T. Enloe	G-10	2.18	.16	1.7	1.42	.24	84	16	15	6.9	49	9.5
P. T. Dalton	G-11	2.32	.14	1.9	1.34	.30	72	20	19	7.3	65	
William E. Dalton	G-12	2.02	.15	2.0	1.66	.29	72	24	24	11.1	65	
County Average		2.12	.14	1.8	1.26	.28	67	20	20	10.2	51	12.2

THE NUTRIENT ELEMENT STATUS OF STAYMAN APPLE LEAVES COLLECTED IN HENDERSON COUNTY, JULY 19, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Bert Lytle	S-1	2.24	.14	1.5	1.32	.30	71	19	20	6.0	48	
S. Schneider	S-2	1.90	.13	1.4	1.02	.27	72	18	20	13.9	44	7.8
Frank L. Fitzsimmons	S-4	1.82	.14	1.7	.92	.22	64	17	20	4.7	42	9.3
M. A. Paxton	S-3	1.96	.14	1.7	.86	.27	59	22	27	5.0	38	7.3
Nun Henderson	S-5	2.21	.12	1.5	1.07	.32	79	17	18	4.9	44	6.8
Glenn Williams	S-6	2.30	.14	1.5	1.07	.25	91	17	17	5.4	47	
Grady Hill	S-7	2.27	.13	1.5	1.04	.28	70	14	16	20.0	54	6.8
Eulis Staton	S-8	2.18	.13	1.4	1.16	.35	79	19	22	5.3	54	
L. A. Enloe	S-9	2.04	.15	1.6	1.34	.37	60	19	22	9.6	52	
W. T. Enloe	S-10	2.21	.14	1.7	1.38	.32	60	22	25	6.0	50	
P. T. Dalton	S-11	2.27	.12	1.4	1.50	.35	68	18	20	6.7	64	10.3
William E. Dalton	S-12	2.07	.14	1.7	1.32	.28	80	19	21	8.2	50	
County Average		2.12	.14	1.5	1.17	.30	71	18	20.7	6.7	49	8.1

THE NUTRIENT ELEMENT STATUS OF DELICIOUS APPLE LEAVES COLLECTED IN WILKES COUNTY, JULY 21, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Clarence Fletcher	D-101	2.07	.13	1.5	.93	.30	67	14	13	5.3	46	12.5
Joe Tevepaugh	D-102	2.07	.15	1.6	.81	.31	82	22	25	5.4	42	7.0
Ed B. Hendren	D-103	2.18	.12	1.6	1.00	.32	55	17	18	8.2	39	7.5
Clarence Hendren	D-104	1.79	.12	1.8	.88	.27	49	16	16	4.9	39	6.5
Boyd Campbell (ABC)	D-105	2.10	.16	1.9	1.21	.29	56	27	35	11.8	48	18.0
Mayford Miller	D-106	2.10	.15	1.4	1.16	.39	99	21	24	9.4	53	11.0
Clyde Lowe	D-107	1.96	.12	1.4	1.10	.27	59	22	27	7.6	39	13.5
Russell Brookshire	D-108	2.02	.13	1.4	1.32	.32	55	15	14	4.9	44	9.8
County Average		2.04	.14	1.6	1.05	.31	65	19	22	7.2	44	10.7

THE NUTRIENT ELEMENT STATUS OF STAYMAN APPLE LEAVES COLLECTED IN WILKES COUNTY, JULY 21, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Clarence Fletcher	S-101	2.10	.13	1.3	1.08	.32	66	15	14	5.4	44	14.8
Joe Tevepaugh	S-102	2.07	.13	1.5	1.08	.28	82	20	22	5.0	34	
Ed B. Hendren	S-103	1.85	.12	1.4	1.02	.30	50	17	19	5.4	23	
Clarence Hendren	S-104	2.18	.13	1.4	1.14	.32	66	12	11	5.1	41	
Boyd Campbell (ABC)	S-105	1.96	.13	1.4	1.27	.30	51	22	25	5.0	34	12.8
Mayford Miller	S-106	2.10	.13	1.3	.97	.29	72	19	20	6.9	28	11.5
Clyde Lowe	S-107	1.88	.12	1.4	1.06	.29	53	19	21	4.6	34	6.3
Russell Brookshire	S-108	1.88	.13	1.3	1.49	.28	62	14	13	7.8	40	5.8
County Average		2.00	.13	1.4	1.14	.30	63	17	18	5.7	35	

THE NUTRIENT ELEMENT STATUS OF GOLDEN DELICIOUS APPLE LEAVES COLLECTED IN WILKES COUNTY, JULY 21, 1955

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Fe	Spec B	B	Cu	Mn	Zn
Clarence Fletcher	G-101	1.93	.15	2.0	1.08	.30	98	21	24	5.6	56	13.5
Joe Tevepaugh	G-102	2.02	.13	1.9	.95	.30	90	24	28	5.8	45	9.0
Clarence Hendren	G-104	2.24	.14	2.2	1.14	.36	86	24	30	6.2	48	7.5
Clyde Lowe	G-107	2.10	.14	2.1	1.12	.32	84	36	52	28.0	50	4.5
Russell Brookshire	G-108	1.85	.14	1.8	1.28	.32	78	22	26	6.0	40	
County Average		2.03	.14	2.0	1.11	.32	87	25	34	10.3	48	8.6

THE NUTRIENT ELEMENT STATUS OF RED DELICIOUS APPLE LEAVES COLLECTED IN ALEXANDER COUNTY, AUGUST 13, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	Mg	Ca	K	Spec B	B	Mn	Fe	Cu	Zn
Clifton St. Clair	130	1.68	.26	.24	1.18	1.6	32	31	61	145	100.0	
H. G. Gryder	128	1.93	.23	.34	.88	1.2	31	31	32	130	12.9	4.9
W. P. Bently	124	2.07	.18	.36	1.13	1.2	28	19	60	166	100.0	11.2
Fred Milstead	138	2.21	.17	.29	.67	1.5	40	40	63	149	9.2	9.0
N. L. Davis	101	1.43	.22	.25	.57	1.6	29	25	46	204	100.0	10.6
D. E. Davis	114	1.74	.30	.29	1.18	1.8	47	35	47	128	100.0	8.4
D. E. Davis	115	1.48	.26	.25	1.06	2.1	44	37	31	90	100.0	11.3
Roby E. Davidson	117	1.88	.18	.28	.70	1.7	23	21	47	81	100.0	9.4
Lonnie Scott	107	1.85	.19	.30	.90	1.5	43	32	83	169	100.0	12.3
Fred Johnson	135	1.93	.17	.32	.86	1.5	34	32	50	127	100.0	10.0
Sherman D. Davis	111	1.79	.23	.32	.81	2.0	44	38	42	237	100.0	12.3
Lee St. Clair	133	1.60	.23	.23	.62	1.6	34	45	34	103	25.4	11.6
Lee St. Clair	134	1.68	.20	.28	.78	1.4	34	35	48	154	10.9	11.8
C. D. Poole	214	1.57	.17	.19	.60	1.3	22	22	34	47	15.3	10.0
County Average		1.79	.21	.28	.85	1.6	35	31	48	138	71.6	9.6

THE NUTRIENT ELEMENT STATUS OF STAYMAN APPLE LEAVES COLLECTED IN ALEXANDER COUNTY, AUGUST 13, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	Mg	Ca	K	Spec B	B	Mn	Fe	Cu	Zn
N. L. Davis	102	1.79	.20	.30	.82	1.3	33	25	52	134	50.0	10.3
N. L. Davis	103	1.68	.20	.29	.69	1.3	31	26	46	226	50.0	10.6
Sherman D. Davis	110	1.79	.20	.31	.95	1.6	34	27	35	202	50.0	10.9
Boyd Campbell	119	1.99	.16	.36	.85	1.6	37	39	56	213	16.1	15.1
Vernon Wike	122	2.04	.19	.34	1.17	1.2	31	12	80	130	50.0	14.4
Parks Hubbard	123	1.68	.17	.32	.92	1.3	24	22	52	189	100.0	22.8
R. G. Clanton	125	1.85	.17	.27	.81	1.8	29	27	36	151	100.0	11.4
F. L. Childers	126	1.88	.18	.26	.86	1.6	32	33	45	209	10.0	13.2
H. G. Gryder	127	1.96	.18	.33	.81	1.2	45	37	34	131	16.2	10.9
J. C. Fortner	132	1.96	.16	.35	1.12	1.4	32	33	56	117	100.0	11.8
D. E. Davis	113	1.88	.18	.24	1.25	1.5	32	21	45	134	50.0	12.3
Roby F. Davidson	118	2.16	.18	.26	.77	1.5	28	22	34	96	50.0	
Fred Johnson	137	2.07	.18	.33	1.12	1.1	37	29	52	260	100.0	12.1
Fred Milstead	139	1.99	.15	.34	.71	1.1	26	30	51	230	9.0	13.0
County Average		1.91	.18	.31	.92	1.4	32	27	48	173	53.7	12.0

THE NUTRIENT ELEMENT STATUS OF GOLDEN DELICIOUS APPLE LEAVES COLLECTED IN ALEXANDER COUNTY, AUGUST 13, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	Mg	Ca	K	Spec B	B	Mn	Fe	Cu	Zn
Sherman D. Davis	109	1.88	.18	.32	.89	1.70	31	19	48	123	50.0	7.9
Vernon Wike	120	1.96	.21	.43	1.25	1.20	33	19	45	193	50.0	10.9
Vernon Wike	121	2.04	.22	.34	1.02	1.20	30	19	47	108	100.0	11.2
J. C. Fortner	131	1.88	.16	.35	.99	1.20	29	26	60	106	100.0	9.8
Fred Milstead	140	2.13	.15	.25	.72	1.50	26	33	54	174	7.9	8.9
D. E. Davis	112	1.74	.24	.28	1.08	1.60	25	21	23	157	50.0	10.9
Roby F. Davidson	116	2.02	.17	.29	.93	1.60	29	18	58	120	50.0	7.9
H. G. Gryder	129	1.85	.18	.38	.87	1.04	32	33	44	104	100.0	7.9
N. L. Davis	104	1.62	.21	.34	.81	1.70	32	25	56	163	8.9	13.0
N. L. Davis	105	1.71	.23	.37	.82	1.40	39	27	67	355	12.9	7 .9
N. L. Davis	106	1.74	.27	.38	.91	1.50	39	28	56	129	11.8	5.3
Lonnie Scott	108	2.02	.20	.35	1.46	1.30	45	31	143	188	50.0	9.0
Fred Johnson	136	2.02	.17	.36	1.04	1.40	30	27	58	110	100.0	8.9
County Average		1.89	.20	.34	.98	1.40	32	25	58	156	53.0	9.2

THE NUTRIENT ELEMENT STATUS OF RED DELICIOUS APPLE LEAVES COLLECTED IN HAYWOOD COUNTY, AUGUST 6, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	Mg	Ca	K	Spec B	B	Mn	Fe	Cu	Zn
Bolling Hall	10	2.27	.19	.41	1.16	1.7	27	35	93	261	13.5	41.3
Henry Francis	8	2.16	.19	.33	1.57	1.6	43	40	61	117	50.0	14.2
Henry Francis	25	2.13	.24	.36	1.65	1.8	56	31	54	123	50.0	15.0
R. N. Barber	55	2.18	.21	.17	.68	1.5	29	36	47	135	6.0	1.5
R. N. Barber	20	2.30	.18	.31	2.25	1.6	34	44	68	123	11.0	12.9
W. K. Boone	14	2.07	.29	.28	1.84	1.6	30	26	50	97	50.0	10.5
Wiley Franklin	88	1.96	.30	.23	.79	1.9	31	34	49	118	8.8	11.0
Pink Coyburn	82	2.18	.22	.22	.88	1.5	31	29	52	114	50.0	10.6
Crosby Frady	30	2.18	.25	.35	1.59	1.7	61	40	71	125	50.0	14.6
Crosby Frady	96	2.27	.25	.26	1.07	1.5	55	40	64	114	50.0	11.8
Z. L. Massey	37	2.30	.24	.47	1.19	1.8	41	29	87	170	11.8	13.1
H. H. Eavenson	12	2.13	.18	.33	.99	1.5	39	50	60	167	50.0	9.8
R. H. Boone	35	2.10	.26	.29	1.93	2.2	70	38	68	249	50.0	12.7
H. L. Morgan	79	2.04	.16	.20	.70	1.8	41	48	60	153	7.7	10.3
County Average		2.16	.23	.30	1.31	1.7	42	37	63	148	32.8	11.4

THE NUTRIENT ELEMENT STATUS OF GOLDEN DELICIOUS APPLE LEAVES COLLECTED IN HAYWOOD COUNTY, AUGUST 6, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	Mg	Ca	K	Spec B	B	Mn	Fe	Cu	Zn
Bolling Hall	28	2.41	.20	.38	1.70	1.7	44	34	97	176	13.9	High
Bolling Hall	9	2.27	.18	.35	1.50	1.2	29	26	81	101	6.7	33.0
R. N. Barber	60	2.32	.19	.22	.88	1.3	32	28	95	138	7.0	13.9
R. N. Barber	32	2.38	.19	.31	1.49	1.5	33	26	69	111	10.5	14.0
Wiley Franklin	66	2.02	.32	.19	.76	1.8	22	26	50	87	7.5	10.1
R. P. McCracken	16	1.96	.36	.22	1.70	1.8	32	26	46	126	21.4	9.5
Pink Cogburn	36	2.04	.22	.20	1.21	2.3	44	30	45	109	50.0	10.4
H. L. Morgan	90	2.16	.18	.26	.82	1.4	51	39	82	229	12.8	12.7
H. L. Morgan	33	2.04	.17	.34	1.79	2.0	57	31	123	138	11.2	9.8
Z. L. Massey	52	2.18	.19	.20	.90	1.4	24	24	45	62	6.0	14.2
H. H. Eavenson	23	2.58	.19	.32	1.35	1.0	32	20	102	132	17.0	11.4
County Average		2.21	.22	.27	1.28	1.6	36	28	76	128	14.9	11.7

THE NUTRIENT ELEMENT STATUS OF ROME BEAUTY APPLE LEAVES COLLECTED IN HAYWOOD COUNTY, AUGUST 6, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	Mg	Ca	K	Spec B	B	Mn	Fe	Cu	Zn
Bolling Hall	53	2.16	.17	.30	.76	1.3	33	30	54	108	8.0	7.4
A. N. Barber	100	2.21	.21	.30	.94	1.4	36	31	82	133	8.6	13.9
A. N. Barber	93	2.35	.24	.23	1.12	1.3	42	35	62	88	6.3	10.4
W. K. Boone	72	2.18	.24	.18	1.00	1.1	32	26	31	228	100.0	10.4
W. K. Boone	24	2.13	.22	.28	1.58	1.2	26	23	51	148	50.0	14.1
Wiley Franklin	3	2.10	.26	.26	1.39	1.7	29	28	69	179	12.9	10.9
Wiley Franklin	49	1.93	.33	.18	.98	1.4	32	32	47	174	7.6	13.6
Jack G. McCracken	98	2.44	.23	.33	1.13	1.5	39	27	68	115	50.0	12.7
Crosby Frady	21	2.13	.23	.34	1.88	1.4	41	51	98	163	50.0	13.2
Crosby Frady	5	1.82	.25	.29	1.78	1.8	41	38	63	134	50.0	8.3
Crosby Frady	68	2.10	.23	.21	1.12	1.2	30	35	62	96	100.0	9.9
County Average		2.14	.24	.26	1.24	1.4	35	32	62	142	40.3	11.3

THE NUTRIENT ELEMENT STATUS OF STAYMAN APPLE LEAVES COLLECTED IN HAYWOOD COUNTY, AUGUST 6, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	Mg	Ca	K	Spec B	B	Mn	Fe	Cu	Zn
Bolling Hall	74	2.13	.24	.30	.92	1.50	46	47	69	218	7.0	
O. D. Ketner	97	1.99	.16	.24	.91	1.50	35	25	41	163	50.0	10.5
R. N. Barber	64	2.21	.16	.22	.63	.90	26	26	46	73	5.3	16.1
R. N. Barber	59	2.30	.16	.26	.74	1.10	26	20	64	138	6.0	13.2
Crosby Frady	63	1.90	.13	.17	.74	1.20	22	23	35	70	100.0	10.4
Crosby Frady	71	1.85	.16	.15	.87	1.40	31	52	33	120	100.0	9.0
H. L. Morgan	42	1.85	.14	.28	1.30	1.70	45	42	86	164	12.4	16.2
Henry Francis	44	1.88	.16	.25	1.55	1.40	38	32	57	127	50.0	17.5
Henry Francis	62	1.85	.14	.18	.83	1.20	28	23	32	104	100.0	15.6
R. H. Boone	95	1.90	.23	.18	1.05	1.60	43	34	39	127	50.0	13.4
Z. L. Massey	7	2.18	.17	.48	1.62	1.30	27	23	93	130	15.5	13.3
H. H. Eavenson	6	2.21	.18	.39	1.30	1.10	33	26	86	160	50.0	13.5
County Average		2.02	.17	.26	1.04	1.30	33	31	57	133	45.5	13.5

THE NUTRIENT ELEMENT STATUS OF RED DELICIOUS APPLE LEAVES COLLECTED IN HENDERSON COUNTY, AUGUST 6, 1956.

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Spec B	B	Mn	Fe	Cu	Zn
William E. Dalton	22	2.16	.12	1.19	.83	.29	25	41	64	203	49.0	10.5
Walter Freeman	56	1.96	.15	1.50	.60	.23	33	36	40	84	100.0	10.4
Berry Laughter	91	2.30	.18	1.60	.73	.20	41	37	53	81	8.8	11.1
Berry Laughter	19	2.30	.12	1.19	.83	.29	12	26	54	109	7.3	8.4
Eulas Staton	46	2.46	.20	1.30	.83	.46	53	47	65	133	9.3	14.1
Grady Hill	67	2.24	.13	1.10	.65	.20	24	33	34	96	19.5	9.5
Newill Hill	99	2.07	.20	1.60	.83	.25	51	42	53	149	50.0	11.6
William J. Nesbitt	78	2.13	.24	1.80	.63	.33	51	42	72	163	11.7	11.2
J. P. Kerr	47	2.18	.17	2.00	1.00	.26	39	28	79	163	14.1	18.9
B. H. Hill	77	2.27	.20	1.60	.77	.23	42	39	66	153	50.0	14.4
L. A. Enloe	81	2.30	.20	1.50	.62	.18	40	37	37	92	7.8	10.4
Avery Pace	70	2.10	.14	.95	.77	.20	25	28	31	102	5.4	12.4
Nun Henderson	44	1.90	.13	1.50	.97	.30	24	28	50	126	50.0	8.6
County Average		2.18	.17	1.45	.77	.26	35	37	54	127	29.5	11.6

THE NUTRIENT ELEMENT STATUS OF STAYMAN APPLE LEAVES COLLECTED IN HENDERSON COUNTY, AUGUST 6, 1956.

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Spec B	B	Mn	Fe	Cu	Zn
William E. Dalton	61	2.02	.14	1.1	.67	.19	27	28	34	115	5.3	11.8
Walter Freeman	40	2.02	.15	1.2	.96	.43	31	32	39	205	50.0	12.7
T. M. Renshaw	75	2.04	.22	1.3	.79	.28	44	35	49	138	10.7	12.0
Otis Lyda	34	2.16	.17	1.5	1.44	.40	48	30	78	97	10.9	13.0
J. P. Kerr	2	1.99	.13	1.6	1.27	.25	26	19	89	138	12.9	12.6
C. C. Freeman	27	2.04	.17	1.5	1.42	.40	47	28	64	209	11.7	18.1
P. V. Lytle	87	2.04	.21	1.4	.72	.22	33	34	46	96	5.6	11.1
Euwell Motes	80	2.30	.21	1.3	.84	.28	44	37	64	140	6.9	12.6
Grady Hill	15	2.16	.14	1.2	1.18	.35	29	21	42	234	50.0	12.7
Eulas Staton	48	2.24	.16	1.2	1.07	.42	36	29	60	166	11.4	16.8
L. A. Enloe	94	2.18	.27	1.2	.86	.27	43	31	43	140	7.9	11.1
Eunice Williams	57	2.16	.15	1.2	.83	.24	24	24	48	111	10.0	14.8
P. T. Dalton	92	1.96	.18	1.3	.92	.27	42	44	52	169	7.8	13.7
Nun Henderson	17	1.93	.12	1.2	1.22	.25	26	21	43	143	50.0	14.5
County Average		2.08	.17	1.3	1.01	.30	36	29	54	150	17.9	13.3

THE NUTRIENT ELEMENT STATUS OF ROME BEAUTY APPLE LEAVES COLLECTED IN HENDERSON COUNTY, AUGUST 6, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	K	Ca	Mg	Spec B	B	Mn	Fe	Cu	Zn
Otho Lyda	86	2.02	.17	1.40	.66	.17	27	29	45	119	50.0	9.3
Walter Freeman	58	2.24	.16	1.20	.90	.26	31	37	48	122	100.0	14.9
Walter Freeman	65	2.32	.14	1.10	.73	.21	28	31	40	155	100.0	18.5
Otis Lyda	11	2.02	.14	1.30	1.11	.30	27	27	66	104	11.3	8.9
H. C. Ballard, Jr.	1	1.90	.14	1.30	1.19	.32	22	24	66	157	15.7	10.4
Grady Hill	84	2.21	.23	1.30	.78	.25	35	29	58	131	16.3	11.0
G. T. Lyda	51	1.99	.17	.90	.91	.25	28	32	50	72	7.8	14.6
William Martin	50	2.27	.16	1.10	.90	.23	30	33	71	101	3.6	13.7
W. F. Barnwell	13	1.82	.21	1.30	1.65	.33	35	26	46	115	50.0	9.0
Eunice Williams	76	2.24	.19	1.20	.92	.23	37	31	70	109	10.8	11.1
Eunice Williams	45	2.27	.16	1.30	1.08	.33	35	26	98	125	14.9	13.5
County Average		2.12	.17	1.20	.98	.26	30	29	60	119	34.6	11.5

THE NUTRIENT ELEMENT STATUS OF RED DELICIOUS APPLE LEAVES COLLECTED IN WILKES COUNTY, AGUST 13, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	Mg	Ca	K	Spec B	B	Mn	Fe	Cu	Zn
Ed Hendren	141	1.99	.17	.28	.70	1.80	42	52	38	185	45.0	11.5
Clarence Hendren	144	2.13	.16	.37	.91	1.60	30	26	70	149	8.2	11.8
M. V. Robinson	147	2.10	.18	.28	.68	1.20	24	27	45	160	100.0	15.8
Austin Triplett	150	2.04	.19	.24	.57	1.10	29	37	38	137	100.0	8.9
Clyde Lowe	152	2.07	.14	.24	.70	1.30	32	39	55	108	100.0	10.6
Clyde Lowe	153	2.16	.14	.22	.81	1.30	31	52	66	98	100.0	50.0
Russell Brookshire	157	2.21	.11	.19	1.00	1.10	25	33	46	83	100.0	12.8
I. J. Broyhill	163	3.00	.12	.23	.39	.84	25	44	41	47	7.1	
J. W. Andrews	165		.14	.17	.46	1.10	29	49	36	75	10.0	
Clarence Fletcher	169	2.02	.13	.24	.93	.87	19	19	50	49	100.0	13.2
James A. Marlow	171	2.07	.15	.25	.81	1.20	29	29	50	90	100.0	4.6
County Average		2.17	.15	.25	.72	1.21	29	37	49	107	70.0	15.5

THE NUTRIENT ELEMENT STATUS OF GOLDEN DELICIOUS APPLE LEAVES COLLECTED IN WILKES COUNTY, AUGUST 13, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	Mg	Ca	K	Spec B	B	Mn	Fe	Cu	Zn
Ed Hendren	142	2.02	.17	.40	.96	1.80	42	40	94	134	100.0	11.1
Clarence Hendren	145	2.10	.14	.28	.63	1.60	28	29	54	120	20.5	11.0
R. C. Adams	148	2.16	.16	.21	.79	1.20	28	37	50	113	10.7	8.9
Clyde Lowe	151	1.90	.14	.26	.71	1.20	27	31	51	153	100.0	9.4
Clyde Lowe	156	2.07	.14	.23	.62	1.40	25	31	55	109	100.0	9.7
Russell Brookshire	158	2.02	.16	.22	.80	1.20	34	45	50	105	100.0	13.2
D. S. Broyhill	161	2.04	.13	.21	.77	1.10	22	33	43	75	7.3	
I. J. Broyhill	164	1.85	.11	.24	.75	.71	25	34	63	50	5.5	18.1
J. W. Andrews	166	1.93	.14	.38	.73	1.20	29	38	52	58	100.0	
Clarence Fletcher	167	1.96	.13	.25	.81	.93	18	25	53	68	100.0	9.4
D. W. Marlow	172	1.82	.17	.21	.76	1.10	21	21	35	38	100.0	2.0
County Average		1.99	.14	.26	.76	1.22	27	33	55	93	67.6	10.3

THE NUTRIENT ELEMENT STATUS OF STAYMAN APPLE LEAVES COLLECTED IN WILKES COUNTY, AUGUST 13, 1956

D. R. Walker

Orchard Owner	Sample Number	Per Cent Dry Weight					Parts Per Million					
		N	P	Mg	Ca	K	Spec B	B	Mn	Fe	Cu	Zn
Ed Hendren	143	2.10	.16	.46	.75	1.01	38	33	58	154	13.4	10.0
Clarence Hendren	146	2.16	.15	.30	.97	1.30	24	25	44	108	20.0	12.5
P. A. Jennings	149	2.07	.18	.18	1.11	1.50	30	33	41	74	100.0	10.8
Clyde Lowe	154	1.99	.17	.23	.67	1.40	30	31	51	74	100.0	12.0
Clyde Lowe	155	1.85	.14	.18	.85	1.50	38	42	43	118	100.0	11.0
Russell Brookshire	159	1.85	.13	.15	.98	1.20	23	36	31	145	100.0	18.1
D. S. Broyhill	160	1.93	.14	.19	.63	1.20	25	34	27	167	10.8	12.1
I. J. Broyhill	162	1.93	.12	.22	.49	.75	22	29	36	86	7.5	13.5
J. W. Andrews	168	1.85	.11	.18	.56	1.00	27	47	36	86	100.0	12.4
Clarence Fletcher	170	1.90	.13	.26	1.24	.94	16	16	36	68	100.0	15.1
County Average		1.96	.14	.24	.83	1.18	27	33	40	108	65.2	12.8

THE NUTRIENT ELEMENT STATUS OF RED DELICIOUS, GOLDEN DELICIOUS AND STAYMAN APPLE LEAVES COLLECTED IN LINCOLN COUNTY, AUGUST 22, 1956

D. R. Walker

Orchard Owner	Sample Number	Variety	Per Cent Dry Weight					Parts Per Million				
			N	P	Mg	Ca	K	B	Mn	Fe	Cu	Zn
J. L. Sain	197	G	1.96	.12	.26	.95	.92	19	62	138	6.0	7.7
J. L. Sain	198	D	2.04	.16	.26	.90	1.30	31	78	200	7.6	9.8
J. L. Sain	201	S	1.82	.13	.28	.99	.99	17	54	160	3.8	10.0
B. D. Leatherman	202	D	1.99	.14	.23	.90	.92	17	48	103	4.4	9.8
B. D. Leatherman	203	S	1.85	.14	.28	1.08	.88	21	42	154	7.6	10.8
B. D. Leatherman	204	G	1.82	.15	.28	.96	1.10	26	52	172	6.3	9.5
D. Rush Beam	205	D	1.43	.13	.16	.63	.95	21	35	90	5.4	8.9
D. Rush Beam	206	S	1.65	.12	.16	.75	.80	15	29	160	4.0	12.0
D. Rush Beam	207	G	1.68	.11	.21	.72	.94	16	43	70	2.8	8.4
John Richardson	208	D	1.79	.14	.24	1.04	.92	20	69	91	5.3	10.5
John Richardson	209	S	1.82	.14	.26	1.23	.84	20	75	133	5.1	12.0
John Richardson	210	G	1.74	.15	.33	1.03	1.10	21	96	120	4.0	10.2
Russell Leatherman	211	G	1.82	.12	.13	.71	.95	16	39	160	4.6	9.4
County Average			1.80	.13	.24	.91	.97	20	55	135	5.1	9.9

THE NUTRIENT ELEMENT STATUS OF RED DELICIOUS, GOLDEN DELICIOUS AND STAYMAN APPLE LEAVES COLLECTED IN STOKES COUNTY, AUGUST 17, 1956

D. R. Walker

Orchard Owner	Sample Number	Variety	Per Cent Dry Weight					Parts Per Million				
			N	P	Mg	Ca	K	B	Mn	Fe	Cu	Zn
Moir Martin	177	G		.14	.36	.74	.66	17	67	61	5.5	
Moir Martin	178	D	2.44	.15	.28	.63	.96	20	70	136	5.0	2.8
Moir Martin	179	S	2.13	.15	.40	.78	.82	19	76	242	7.4	2.9
Carl Ayers	180	D	2.21	.17	.33	.59	.88	26	58	118	6.0	3.0
Carl Ayers	181	G	1.96	.16	.24	.87	.91	18	87	112	4.2	2.8
Carl Ayers	182	S	2.07	.16	.29	.72	.99	22	47	98	5.5	8.1
Raymond Handy	183	G	1.93	.15	.29	.82	1.20	17	53	164	100.0	12.0
Raymond Handy	184	S	2.04	.14	.31	.97	1.00	20	67	235	100.0	16.2
Raymond Handy	185	D	2.02	.14	.23	.60	1.10	19	50	127	6.5	14.4
County Average			2.10	.15	.30	.75	.95	20	64	144	26.7	7.8

THE NUTRIENT ELEMENT STATUS OF RED DELICIOUS, GOLDEN DELICIOUS AND STAYMAN APPLE LEAVES COLLECTED IN CLEVELAND COUNTY, AUGUST 22, 1956

D. R. Walker

Orchard Owner	Sample Number	Variety	Per Cent Dry Weight					Parts Per Million				
			N	P	Mg	Ca	K	B	Mn	Fe	Cu	Zn
Wayne L. and Cameron Ware	186	D	1.88	.14	.30	.87	1.10	22	60	162	7.4	12.0
"	187	S	1.82	.14	.31	.91	.97	21	54	137	4.3	15.0
"	188	G	2.02	.15	.26	.92	.94	21	70	132	3.8	1.3
"	189	D	1.93	.15	.27	.73	1.00	21	64	144	7.4	12.9
Mrs. J. D. Elliott	190	G	1.90	.15	.30	.96	1.20	25	54	166	4.8	10.4
"	191	D	1.99	.16	.29	.73	1.10	32	50	254	8.2	10.8
B. H. Greigg	192	D	1.79	.17	.30	1.00	.98	26	79	161	6.2	10.2
"	193	S	1.88	.14	.19	1.04	.82	20	48	121	6.5	11.5
"	194	G	1.65	.14	.21	.97	.71	18	60	200	5.1	10.9
E. Lutz	195	D	2.07	.15	.32	1.16	.91	19	91	137	9.1	23.9
"	196	S	2.38	.17	.24	.76	1.20	26	72	149	7.3	11.6
"	199	G	2.27	.14	.26	1.19	.81	18	88	161	4.7	11.6
"	200	G	2.24	.14	.22	1.08	.73	17	66	104	3.2	13.5
County Average			1.99	.15	.27	.95	.96	22	66	156	6.0	12.9

THE NUTRIENT ELEMENT STATUS OF STAYMAN AND GOLDEN DELICIOUS APPLE LEAVES
COLLECTED IN SURRY COUNTY, AUGUST 17, 1956

D. R. Walker

Orchard Owner	Sample Number	Variety	Per Cent Dry Weight					Parts Per Million				
			N	P	Mg	Ca	K	B	Mn	Fe	Cu	Zn
S. R. Poole	173	G	1.82	.13	.27	.85	.88	20	58	153	5.1	9.7
E. C. Collins	174	G	1.85	.15	.28	.72	1.00	21	47	114	5.8	7.4
E. C. Collins	175	S	2.04	.15	.32	.71	.98	18	39	84	8.5	3.7
Banner Orchards	176	G	1.79	.12	.29	.53	1.00	23	44	109	7.8	2.8
County Average			1.87	.14	.29	.70	.96	20	47	115	6.8	5.9

The Analytical Analysis of Surface Soil Collected Underneath Trees in Alexander County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Vernon Wike	65	6.2	5.50	1.46	o.088	100.0	0.210	2.3
Roby Davidson	69	5.8	1.60	0.56	0.068	49.0	0.350	2.6
Boyd Campbell	73	5.9	1.30	0.54	0.190	19.0	0.270	2.7
Parks Hubbard	77	5.9	1.40	0.56	0.114	49.0	0.430	2.5
D. E. Davis	81	7.5	8.00	2.90	0.088	110.0	0.420	2.7
Sherman Davis	85	6.6	8.00	2.08	0.105	43.0	0.340	3.1
Lonnie Scott	89	5.2	1.10	1.00	0.105	24.0	0.220	4.5
Clifton St. Clair	93	6.8	7.40	0.74	0.097	100.0	0.330	2.9
F. L. Childers	97	5.9	4.60	0.70	0.105	92.0	0.255	3.2
H. G. Gryder	101	7.1	8.00	1.86	0.046	43.0	0.165	3.6
Roy Clanton	105	7.3	6.40	1.18	0.114	53.0	0.330	3.0
W. P. Bentley	109	6.0	8.00	0.66	0.800	122.0	0.225	2.8
C. D. Poole	113	5.8	4.40	0.56	0.041	100.0	0.250	3.2
Fred Johnson	117	5.9	0.50	0.41	0.105	7.0	0.160	2.4
J. C. Fortner	121	5.8	2.30	0.39	0.212	46.0	0.220	3.5
N. L. Davis	125	6.2	4.40	2.00	0.068	31.0	0.160	2.5
Total		99.9	72.90	17.60	2.346	988.0	4.334	47.5
Average		6.24	4.556	1.100	.1466	61.75	.2709	2.97

The Analytical Analysis of Subsoil Collected Underneath Trees in Alexander County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Vernon Wike	66	5.9	0.90	0.79	0.068	31.0	0.225	2.0
Roby Davidson	70	5.7	0.70	0.52	0.057	19.0	0.250	1.9
Boyd Campbell	74	5.7	0.60	0.37	0.265	2.0	0.230	1.8
Parks Hubbard	78	5.4	0.50	0.39	0.123	21.0	0.340	1.8
D. E. Davis	82	7.3	5.90	1.27	0.097	14.0	0.390	1.3
Sherman Davis	86	6.7	3.10	1.32	0.080	9.0	0.290	1.9
Lonnie Scott	90	5.0	0.60	0.41	0.080	13.0	0.200	3.5
Clifton St. Clair	94	5.7	0.70	0.47	0.097	12.0	0.270	1.5
F. L. Childers	98	6.7	0.60	0.32	0.080	8.0	0.275	1.7
H. G. Gryder	102	6.6	1.50	1.78	0.041	9.0	0.175	1.7
Roy Clanton	106	6.6	0.50	0.75	0.105	15.0	0.215	2.0
W. P. Bentley	110	5.4	0.90	0.35	0.057	36.0	0.145	2.1
C. D. Poole	114	5.6	1.40	0.62	0.022	38.0	0.225	2.0
Fred Johnson	118	5.2	0.65	0.25	0.141	5.0	0.165	2.1
J. C. Fortner	122	5.4	0.60	0.10	0.265	8.0	0.170	2.0
N. L. Davis	126	6.1	4.60	2.40	0.054	10.0	0.120	1.7
Total		95.0	23.75	12.11	1.632	250.0	3.685	31.0
Average		5.94	1.484	.757	.1020	15.62	.2303	1.94

The Analytical Analysis of Surface Soil Collected In Row Middles in Alexander County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Vernon Wike	67	6.1	2.40	0.89	0.880	46.0	0.235	3.0
Roby Davidson	71	6.0	2.00	0.67	0.062	9.0	0.270	2.9
Boyd Campbell	75	6.1	1.10	0.85	0.190	6.0	0.280	2.5
Parks Hubbard	79	6.0	0.70	0.79	0.123	12.0	0.360	2.5
D. E. Davis	83	7.1	8.00	2.26	0.105	55.0	0.400	2.6
Sherman Davis	87	6.5	3.30	1.32	0.074	9.0	0.200	2.6
Lonnie Scott	91	5.8	1.60	1.22	0.097	10.0	0.340	4.4
Clifton St. Clair	95	6.5	2.60	1.48	0.131	11.0	0.275	2.4
F. L. Childers	99	6.2	1.00	0.35	0.088	2.5	0.275	2.4
H. G. Gryder	103	6.7	7.40	2.86	0.052	11.0	0.150	3.0
Roy Clanton	107	6.8	1.70	1.27	0.097	8.0	0.210	2.3
W. P. Bentley	111	6.4	1.30	0.89	0.062	15.00	0.120	2.6
C. D. Poole	115	5.7	1.50	0.93	0.027	6.00	0.210	2.9
Fred Johnson	119	5.8	0.65	0.47	0.114	7.00	0.115	2.3
J. C. Fortner	123	5.9	1.00	0.50	0.160	4.00	0.200	2.7
N. L. Davis	127	6.3	1.60	1.43	0.068	18.0	0.115	2.3
Total		99.9	37.85	18.18	2.330	229.5	3.755	43.5
Average		6.24	2.366	1.136	.145	14.34	.2347	2.72

The Analytical Analysis of Subsoil Collected In Row Middles in Alexander County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Vernon Wike	68	5.8	0.65	0.67	0.062	19.0	0.190	1.7
Roby Davidson	72	5.7	0.70	0.52	0.074	3.0	0.210	1.8
Boyd Campbell	76	5.7	0.30	0.50	0.201	2.0	0.205	1.6
Parks Hubbard	80	5.8	0.40	0.62	0.105	6.0	0.265	1.9
D. E. Davis	84	7.1	1.90	1.27	0.088	6.0	0.275	1.1
Sherman Davis	88	6.4	1.10	1.08	0.080	2.5	0.140	1.6
Lonnie Scott	92	5.5	0.70	0.67	0.088	4.0	0.180	3.4
Clifton St. Clair	96	6.4	1.40	0.93	0.105	3.5	0.195	1.3
F. L. Childers	100	6.1	0.65	0.26	0.080	1.5	0.215	1.3
H. G. Gryder	104	7.9	6.40	2.40	0.046	3.5	0.130	1.6
Roy Clanton	108	6.4	1.10	0.85	0.105	5.0	0.160	1.8
W. P. Bentley	112	6.1	0.70	0.62	0.057	4.0	0.075	1.6
C. D. Poole	116	5.5	0.90	0.73	0.018	3.0	0.150	1.8
Fred Johnson	120	5.6	0.50	0.26	0.131	5.0	0.115	1.7
J. C. Fortner	124	6.0	0.65	0.58	0.223	3.0	0.155	2.0
N. L. Davis	128	6.2	1.10	1.55	0.068	13.0	0.100	1.7
Total		98.2	19.15	13.51	1.531	84.0	2.780	27.9
Average		6.14	1.197	.844	.0957	5.25	.1738	1.74

The Analytical Analysis of Surface Soil Collected Underneath Trees in Haywood County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Crosby Frady	129	5.4	8.00	0.78	0.223	92.0	0.490	5+
R. P. McCracken	133	6.2	8.00+	1.32	0.201	64.0	0.480	4.6
W. K. Boone	137	6.6	7.60	1.43	0.340	13.0	0.570	3.4
Pink Cogburn	141	6.4	8.00+	1.43	0.248	33.0	0.780	4.1
Wiley Franklin	145	5.9	4.20	1.16	0.492	84.0	0.630	2.9
Jack McCracken	149	6.4	7.60	1.48	0.223	19.0	0.360	3.9
H. L. Morgan	153	6.7	8.0+	4.45	0.600	12.0	0.330	3.8
Henry Francis	157	5.8	6.4	0.60	0.300	110.0	0.615	3.4
Z. L. Massey	161	6.3	7.6	1.46	0.600	49.0	0.690	3.9
R. N. Barber	165	6.3	7.0	1.22	0.223	33.0	0.380	3.7
Bolling Hall	169	5.9	8.0	1.88	0.265	36.0	0.380	5+
R. H. Boone	173	6.1	8.0+	1.22	0.235	26.0	0.560	4.3
H. H. Eavenson	177	5.8	8.0+	3.35	0.123	122.0	0.205	4.9
Total		79.8	96.5	21.78	4.073	693.0	6.470	52.9
Average		6.14	7.42	1.675	.3133	53.31	.4977	4.07

The Analytical Analysis of Subsoil Collected Underneath Trees in Haywood County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Crosby Frady	130	5.4	2.60	0.79	0.280	38.0	0.460	3.3
R. P. McCracken	134	6.2	7.60	1.13	0.248	24.0	0.340	3.1
W. K. Boone	138	6.3	2.40	1.18	0.340	9.0	0.480	2.1
Pink Cogburn	142	6.2	1.10	1.08	0.212	9.0	0.340	2.4
Wiley Franklin	146	6.2	4.0	1.13	0.456	46.0	0.420	1.8
Jack McCracken	150	6.7	6.4	1.48	0.248	10.0	0.350	2.9
H. L. Morgan	154	6.7	2.0	1.08	0.848	6.0	0.205	1.8
Henry Francis	158	6.1	7.6	1.02	0.400	110.0	0.690	2.6
Z. L. Massey	162	6.2	3.6	0.97	0.640	12.0	0.570	2.4
R. N. Barber	166	5.8	2.3	1.00	0.235	18.0	0.260	2.9
Bolling Hall	170	5.6	2.2	1.18	0.300	6.0	0.220	4.4
R. H. Boone	174	5.9	8.0	0.93	0.248	6.0	0.520	3.4
H. H. Eavenson	178	5.7	2.6	1.58	0.131	92.0	0.240	3.5
Total		79.0	52.4	14.55	4.586	386.0	5.095	36.6
Average		6.08	4.03	1.119	.3528	29.69	.3919	2.82

The Analytical Analysis of Surface Soil Collected In Row Middles in Haywood County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Crosby Frady	131	6.2	8.00+	1.13	0.201	31.0	0.460	4.8
R. P. McCracken	135	6.3	8.00+	1.86	0.201	55.0	0.480	4.5
W. K. Boone	139	6.3	4.40	1.13	0.320	13.0	0.450	3.5
Pink Cogburn	143	6.0	3.50	1.37	0.228	24.0	0.645	3.5
Wiley Franklin	147	6.0	5.90	1.28	0.524	92.0	0.550	2.8
Jack McCracken	151	6.8	8.0+	5.00	0.248	92.0	0.390	3.9
H. L. Morgan	155	6.7	8.0	1.18	0.564	10.0	0.245	3.2
Henry Francis	159	6.2	7.6	1.22	0.340	49.0	0.510	3.6
Z. L. Massey	163	6.2	3.6	1.13	0.600	18.0	0.615	3.2
R. N. Barber	167	6.4	8.0	1.43	0.223	31.0	0.270	4.1
Bolling Hall	171	5.9	8.0	1.48	0.248	14.0	0.285	5+
R. H. Boone	175	5.9	8.0	1.22	0.248	26.0	0.390	4.0
H. H. Eavenson	179	6.6	8.0+	3.24	0.150	110.0	0.240	3.5
Total		81.5	89.0	22.67	4.095	565.0	5.530	49.6
Average		6.27	6.85	1.744	.3150	43.46	.4254	3.82

The Analytical Analysis of Subsoil Collected In Row Middles in Haywood county in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Crosby Frady	132	5.9	4.00	0.75	0.280	19.0	0.380	3.0
R. P. McCracken	136	6.4	8.00	1.27	0.248	26.0	0.263	3.2
W. K. Boone	140	6.0	1.50	1.04	0.365	6.0	0.205	2.1
Pink Cogburn	144	5.8	0.65	1.00	0.150	3.5	0.245	1.7
Wiley Franklin	148	6.2	3.30	1.08	0.564	64.0	0.420	1.8
Jack McCracken	152	7.3	8.0+	4.85	0.248	21.0	0.360	2.7
H. L. Morgan	156	6.5	1.6	0.89	0.564	3.0	0.100	1.7
Henry Francis	160	6.3	5.5	1.13	0.420	33.0	0.360	2.2
Z. L. Massey	164	6.2	2.6	1.04	0.564	8.0	0.450	2.1
R. N. Barber	168	6.1	5.5	1.27	0.223	13.0	0.205	3.1
Bolling Hall	172	5.9	3.8	1.37	0.265	4.0	0.175	4.9
R. H. Boone	176	5.7	8.0	0.82	0.265	4.0	0.240	3.0
H. H. Eavenson	180	6.3	5.5	1.94	0.170	64.0	0.205	4.0
Total		80.6	57.94	18.45	4.326	268.5	3.608	35.5
Average		6.20	4.46	1.419	.3328	20.65	.2775	2.73

The analytical Analysis of Surface Soil Collected Underneath trees in Henderson County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Walter Freeman	1	6.4	2.00	1.18	0.131	38.	0.390	2.5
T. N. Renshaw	5	5.8	1.10	0.79	0.097	13.0	0.195	2.5
J. P. Kerr	9	5.3	6.40	0.18	0.564	42.0	0.520	3.9
P. T. Dalton	13	5.4	2.00	0.52	0.388	31.0	0.245	4.1
J. Newill Hill	17	6.3	1.40	0.58	0.068	26.0	0.480	3.4
Eunice Williams	21	5.4	1.05	0.26	0.201	33.0	0.400	3.0
Bert Ledbetter	25	6.3	2.30	0.97	0.141	40.0	0.230	2.6
Grady Hill	29	5.9	1.70	1.08	0.046	14.0	0.155	3.7
W. K. Dalton	33	5.7	3.30	0.09	0.141	110.0	0.450	3.4
Berry Laughter	37	5.7	2.30	0.64	0.074	53.0	0.370	2.5
Otho Lyda	41	4.8	0.65	0.26	0.068	40.0	0.285	2.3
L. A. Enloe	45	5.7	1.80	0.37	0.068	70.0	1.040	3.0
B. N. Hill	49	6.3	2.60	1.37	0.097	36.0	0.240	3.3
Eulis Statin	53	5.9	8.00	0.90	0.223	140.0	0.675	3.0
E. Motes	57	5.8	5.20	0.75	0.212	140.0	0.510	3.7
Nun Henderson	61	5.0	0.80	0.11	0.041	24.0	0.175	3.9
Total		91.7	42.60	10.05	2.560	850.0	6.360	50.8
Average		5.73	2.662	.6281	.1600	53.12	.3975	3.17

The Analytical Analysis of Subsoil Collected Underneath trees in Henderson County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Walter Freeman	2	6.6	1.05	1.32	0.141	7.0	0.235	1.7
T. N. Renshaw	6	6.0	0.65	0.97	0.062	2.5	0.125	1.3
J. P. Kerr	10	5.1	0.70	0.19	0.720	15.0	0.380	2.4
P. T. Dalton	14	5.0	0.40	0.22	0.340	8.0	0.210	2.4
J. Newill Hill	18	5.7	0.25	0.47	0.057	5.0	0.390	2.2
Eunice Williams	22	5.4	0.70	0.22	0.201	10.0	0.270	1.9
Bert Ledbetter	26	6.2	1.05	0.85	0.123	14.0	0.190	1.7
Grady Hill	30	5.2	0.40	0.45	0.022	3.5	0.155	2.1
W. T. Dalton	34	5.2	0.40	0.10	0.180	18.0	0.380	1.5
Berry Laughter	38	5.9	1.00	0.54	0.068	24.0	0.280	1.8
Otho Lyda	42	5.0	0.50	0.14	0.123	26.0	0.215	1.9
L. A. Enloe	46	6.4	1.80	0.28	0.057	24.0	0.330	2.1
B. N. Hill	50	5.3	0.65	0.67	0.097	18.0	0.160	3.2
Eulis Staton	54	5.6	2.60	0.72	0.235	78.0	0.690	1.7
E. Motes	58	5.5	0.30	0.34	0.150	14.0	0.290	2.0
Nun Henderson	62	5.2	0.65	0.20	0.041	10.0	0.180	2.7
Total		89.3	13.10	7.68	2.617	277.0	4.480	32.6
Average		5.58	.818	.480	.1636	17.31	.2800	2.037

The Analytical Analysis of Surface Soil Collected In Row Middles in Henderson County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Walter Freeman	3	6.7	1.10	1.32	0.150	5.0	0.210	2.0
T. N. Renshaw	7	6.8	8.00	1.55	0.097	49.0	0.160	2.9
J. P. Kerr	11	5.7	2.40	0.50	0.680	21.0	0.380	3.6
P. T. Dalton	15	6.1	2.20	1.08	0.340	15.0	0.350	3.6
J. Newill Hill	19	5.8	1.10	0.73	0.057	14.0	0.220	3.2
Eunice Williams	23	5.5	2.30	1.27	0.223	26.0	0.270	3.0
Bert Ledbetter	27	5.7	4.00	0.36	0.150	110.0	0.330	2.7
Grady Hill	31	6.3	4.40	1.48	0.057	14.0	0.195	4.2
W. T. Dalton	35	6.3	1.70	0.85	0.212	31.0	0.220	2.5
Berry Laughter	39	6.4	2.00	1.18	0.074	46.0	0.390	2.1
Otho Lyda	43	5.7	1.20	0.54	0.057	38.0	0.255	2.1
L. A. Enloe	47	5.6	1.30	0.67	0.062	36.0	0.210	2.9
B. N. Hill	51	6.2	2.90	1.43	0.088	33.0	0.200	3.8
Eulis Staton	55	6.2	6.40	1.60	0.212	33.0	0.340	2.4
E. Motes	59	6.0	2.70	1.32	0.190	33.0	0.245	3.8
Nun Henderson	63	5.7	2.20	0.85	0.046	21.0	0.320	3.6
Total		96.7	45.90	16.73	2.695	525.0	4.295	48.4
Average		6.04	2.868	1.045	.1684	32.813	.2684	3.02

The Analytical Analysis of Subsoil Collected In Row Middles in Henderson County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Walter Freeman	4	6.6	0.90	1.37	0.150	3.5	0.150	1.6
T. N. Renshaw	8	6.8	1.40	1.37	0.080	10.0	0.085	1.7
J. P. Kerr	12	5.3	0.70	0.25	0.640	4.0	0.280	2.2
P. T. Dalton	16	5.8	0.50	0.75	0.320	5.0	0.215	2.7
J. Newill Hill	20	5.7	0.60	0.58	0.046	3.0	0.125	1.8
Eunice Williams	24	5.3	0.50	0.43	0.212	7.0	0.150	1.9
Bert Ledbetter	28	5.8	1.40	0.39	0.150	53.0	0.330	1.6
Grady Hill	32	5.8	1.10	1.08	0.046	9.0	0.155	3.0
W. T. Dalton	36	6.2	0.80	0.62	0.190	5.0	0.120	1.4
Berry Laughter	40	6.5	1.10	1.00	0.057	15.0	0.185	1.5
Otho Lyda	44	5.0	0.30	0.43	0.052	19.0	0.225	1.6
L. A. Enloe	48	5.7	0.80	0.54	0.062	21.0	0.160	1.9
B. N. Hill	52	5.2	1.05	0.75	0.105	18.0	0.140	3.7
Eulis Staton	56	5.9	1.30	1.18	0.201	9.0	0.175	2.0
E. Motes	60	5.7	0.70	0.75	0.170	10.0	0.155	2.0
Nun Henderson	64	5.8	0.90	0.85	0.041	8.0	0.210	3.0
Total		93.1	14.05	12.32	2.552	199.5	2.860	33.6
Average		5.81	.873	.770	.1595	12.469	.1788	2.10

The Analytical Analysis of Surface Soil Collected Underneath Trees in Wilkes County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
R. C. Adams	245	6.1	2.90	0.34	0.185	31.0	0.260	3.9
R. Brookshire	249	5.2	3.80	0.30	0.308	23.0	0.230	4.3
Clarence Hendren	253	5.4	1.50	0.58	0.180	13.0	0.210	3.9
Ed Hendren	257	5.6	1.70	0.93	0.136	17.0	0.155	3.4
D. S. Broyhill	261	6.2	8.00	0.82	0.330	46.0	0.275	3.3
D. W. Marlow	265	6.5	8.00	1.27	0.068	7.0	0.330	3.4
I. J. Broyhill	269	6.2	2.70	1.04	0.131	8.0	0.120	3.9
Clyde Lowe	273	5.5	2.00	0.30	0.165	28.0	0.255	3.6
A. Tripett	277	5.7	4.20	1.00	0.146	46.0	0.235	4.2
P. A. Jennings	281	5.8	3.50	0.67	0.114	43.0	0.380	4.0
M. V. Robinson	285	5.5	1.60	0.32	0.071	24.0	0.220	3.8
Clarence Fletcher	289	5.5	2.20	0.47	0.080	12.0	0.200	3.9
J. A. Marlow	293	6.2	8.00	1.16	0.175	70.0	0.270	3.4
N. C. Andrews	297	5.2	0.40	0.64	0.235	2.0	0.100	3.5
Total		80.6	50.50	9.84	2.324	370.0	3.240	52.5
Average		5.76	3.607	.7029	.1660	26.43	.2314	3.75

The Analytical Analysis of Subsoil Collected Underneath Trees in Wilkes County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
R. C. Adams	246	5.7	0.65	0.08	0.141	4.0	0.165	2.3
R. Brookshire	250	5.2	1.05	0.22	0.388	4.0	0.220	2.7
Clarence Hendren	254	5.2	0.25	0.26	0.131	16.0	0.165	1.8
Ed Hendren	258	5.4	0.60	0.52	0.109	6.0	0.120	2.4
D. S. Broyhill	262	6.0	1.05	0.62	0.290	6.0	0.290	1.7
D. W. Marlow	266	6.1	1.05	0.79	0.054	11.0	0.240	2.1
I. J. Broyhill	270	6.1	1.20	0.54	0.080	2.5	0.075	2.1
Clyde Lowe	274	5.2	0.70	0.15	0.141	3.5	0.235	2.2
A. Tripett	278	5.2	0.50	0.54	0.046	3.5	0.165	1.7
P. A. Jennings	282	5.4	0.80	0.43	0.097	6.0	0.350	1.9
M. V. Robinson	286	5.2	0.30	0.12	0.080	4.0	0.140	2.2
Clarence Fletcher	290	5.3	0.65	0.28	0.068	2.5	0.130	1.9
J. A. Marlow	294	5.7	0.65	0.64	0.141	4.0	0.180	2.0
N. C. Andrews	298	5.4	0.30	0.47	0.223	2.0	0.130	2.1
Total		77.1	9.75	5.66	1.989	75.0	2.605	29.1
Average		5.51	.696	.404	.1421	5.36	.1861	2.08

The Analytical Analysis of Surface Soil Collected In Row Middles in Wilkes County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
R. C. Adams	247	5.6	1.60	0.43	0.217	5.0	0.195	3.6
R. Brookshire	251	5.7	3.30	0.85	0.340	2.5	0.275	3.8
Clarence Hendren	255	5.9	1.80	1.00	0.170	6.0	0.220	3.5
Ed Hendren	259	6.4	5.50	1.60	0.123	13.0	0.155	3.3
D. S. Broyhill	263	5.8	2.30	0.79	0.340	8.0	0.255	3.1
D. W. Marlow	267	5.5	0.65	0.62	0.041	3.5	0.185	2.0
I. J. Broyhill	271	6.8	3.30	1.48	0.131	2.5	0.085	3.5
Clyde Lowe	275	5.9	1.70	0.89	0.175	12.0	0.290	3.4
A. Tripett	279	6.4	2.70	1.13	0.131	11.0	0.185	3.7
P. A. Jennings	283	5.6	1.80	0.70	0.127	17.0	0.220	3.8
M. V. Robinson	287	5.7	0.40	0.73	0.118	5.0	0.160	2.9
Clarence Fletcher	291	6.0	3.80	1.08	0.088	9.0	0.205	3.6
J. A. Marlow	295	6.0	1.60	0.79	0.165	5.0	0.195	3.1
N. C. Andrews	299	7.1	6.40	1.78	0.272	4.0	0.175	2.9
Total		84.4	36.85	13.87	2.438	103.5	2.800	46.2
Average		6.03	2.632	.991	.1741	7.39	.200	3.30

The Analytical Analysis of Subsoil Collected In Row Middles in Wilkes County in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
R. C. Adams	248	5.6	0.65	0.30	0.146	3.0	0.115	2.0
R. Brookshire	252	5.7	1.50	0.58	0.308	3.5	0.155	2.3
Clarence Hendren	256	5.9	0.60	0.64	0.136	2.0	0.190	1.9
Ed Hendren	260	6.2	0.50	0.85	0.085	2.5	0.090	1.7
D. S. Broyhill	264	5.7	0.60	0.62	0.330	2.0	0.165	1.4
D. W. Marlow	268	5.4	0.50	0.52	0.041	2.0	0.140	1.2
I. J. Broyhill	272	6.5	0.80	0.85	0.085	2.0	0.055	1.7
Clyde Lowe	276	5.7	0.60	0.70	0.175	2.5	0.180	2.0
A. Tripett	280	5.9	2.20	0.97	0.046	3.0	0.125	1.6
P. A. Jennings	284	5.4	0.65	0.41	0.105	3.0	0.155	2.8
M. V. Robinson	288	5.7	0.65	0.64	0.065	2.5	0.090	1.9
Clarence Fletcher	292	6.0	0.80	0.89	0.054	2.0	0.070	1.7
J. A. Marlow	296	5.9	0.50	0.67	0.123	2.0	0.125	2.0
N. C. Andrews	300	6.1	0.40	1.22	0.100	1.5	0.130	1.1
Total		81.7	10.95	9.86	1.799	33.5	1.785	25.3
Average		5.84	.782	.704	.1285	2.39	.1275	1.81

The Analytical Analysis of Surface Soil Collected Underneath Trees in Stokes and Surry Counties in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Carl Ayers	181	6.3	1.70	1.18	0.052	17.0	0.205	3.2
Raymond Handy	185	6.7	2.70	1.55	0.170	23.0	0.490	2.7
Banner Orchards	189	6.4	8.00+	6.85	0.052	3.5	0.155	3.0
S. R. Poole	193	6.0	7.40	1.43	0.074	10.0	0.190	4.2
Moir Martin	197	6.6	1.90	1.43	0.068	11.0	0.340	3.5
E. C. Collins	201	6.4	2.00	1.18	0.074	24.0	0.215	2.9
Total		38.4	23.70	13.62	0.490	88.5	1.595	19.5
Average		6.4	3.95	2.270	.0817	14.75	.2658	3.25

The Analytical Analysis of Subsoil Collected Underneath Trees in Stokes and Surry Counties in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	K	P	O.M.
			me/100g	me/100g	me/100g	me/100g	ppm	me/100g
Carl Ayers	182	5.8	0.40	0.79	0.032	0.130	3.5	2.0
Raymond Handy	186	6.6	0.80	1.18	0.131	0.370	3.5	1.4
Banner Orchards	190	6.4	2.70	1.32	0.032	0.140	9.0	1.6
S. R. Poole	194	5.8	3.60	1.68	0.080	0.150	6.0	3.1
Moir Martin	198	6.0	0.60	1.32	0.057	0.145	4.0	2.3
E. C. Collins	202	6.0	0.65	0.89	0.062	0.180	7.0	1.5
Total		36.6	8.75	7.18	0.394	1.115	33.0	11.9
Average		6.1	1.458	1.197	.0657	.1858	5.5	1.98

The Analytical Analysis of Surface Soil Collected In Row Middles in Stokes and Surry Counties in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Carl Ayers	183	6.0	1.05	1.27	0.046	7.0	0.140	3.3
Raymond Handy	187	6.9	7.60	3.10	0.180	28.0	0.390	2.4
Banner Orchards	191	6.5	8.00+	8.90	0.068	2.5	0.090	2.9
S. R. Poole	195	6.8	8.00	2.00	0.074	12.0	0.230	4.5
Moir Martin	199	6.5	1.60	1.43	0.062	8.0	0.195	2.7
E. C. Collins	203	6.6	4.00	1.43	0.088	40.0	0.200	2.9
Total		39.3	30.25	18.13	0.518	97.5	1.245	18.7
Average		6.55	5.042	3.022	.0863	16.25	.2075	3.12

The Analytical Analysis of Subsoil Collected In Row Middles in Stokes and Surry Counties in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
Carl Ayers	184	5.6	0.60	0.85	0.032	3.0	0.095	2.1
Raymond Handy	188	6.2	1.00	1.13	0.123	3.5	0.255	1.4
Banner Orchards	192	6.3	7.40	6.60	0.041	2.0	0.065	1.6
S. R. Poole	196	6.5	8.00+	6.60	0.057	3.5	0.115	2.7
Moir Martin	200	5.3	0.65	0.93	0.037	3.0	0.115	1.5
E. C. Collins	204	6.5	1.20	1.27	0.074	11.0	0.110	1.8
Total		36.4	18.85	17.38	0.364	26.0	.755	11.1
Average		6.07	3.142	2.897	.0607	4.33	.1258	1.85

The Analytical Analysis of Surface Soil Collected Underneath Trees in Cleveland and Lincoln Counties in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
John Richardson	205	6.2	8.00+	0.51	0.524	122.0	0.420	2.0
J. D. Elliott	209	7.6	8.00+	5.65	0.150	46.0	0.330	3.3
Cameron Ware	213	5.6	1.50	0.60	0.027	92.0	0.150	2.1
Russell Leatherman	217	6.3	5.90	1.00	0.071	55.0	0.260	3.5
Everette Lutz	221	5.2	2.30	0.22	0.105	122.0	0.240	3.0
J. L. Sain	225	6.5	8.0+	0.90	0.097	122.0	0.230	2.9
B. H. Greigg	229	6.3	1.60	0.73	0.235	43.0	0.280	2.4
D. Rush Beam	233	6.2	1.30	0.41	0.093	36.0	0.180	2.2
B. G. Leatherman	237	6.6	8.00+	0.20	0.190	84.0	0.300	2.4
Total		56.5	44.6	10.22	1.492	722.0	2.390	23.8
Average		6.28	4.956	1.136	.1658	80.22	.2656	2.64

The Analytical Analysis of Subsoil Collected Underneath Trees in Cleveland and Lincoln Counties in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
John Richardson	206	5.6	0.90	0.37	0.300	10.0	.490	0.8
J. D. Elliott	210	7.3	1.80	1.43	0.131	23.0	0.330	1.4
Cameron Ware	214	4.7	0.60	0.19	0.014	14.0	0.130	1.0
Russell Leatherman	218	5.8	1.40	0.75	0.074	33.0	0.340	1.8
Everette Lutz	222	5.3	1.00	0.18	0.105	64.0	0.245	1.7
J. L. Sain	226	6.1	1.50	0.67	0.062	43.0	0.285	1.5
B. H. Greigg	230	5.8	0.70	0.34	0.372	23.0	0.210	2.3
D. Rush Beam	234	5.5	0.60	0.28	0.049	3.0	0.130	1.0
B. G. Leatherman	238	6.0	1.50	0.32	0.093	17.0	0.195	1.5
Total		52.1	10.00	4.53	1.200	230.0	2.355	13.0
Average		5.79	1.111	.503	.1333	25.56	.2617	1.44

The Analytical Analysis of Surface Soil Collected In Row Middles in Cleveland and Lincoln Counties in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
John Richardson	207	6.2	1.70	0.58	0.564	15.0	0.250	2.2
J. D. Elliott	211	6.1	8.00	2.46	0.170	122.0	0.380	4.1
Cameron Ware	215	6.3	5.20	1.04	0.032	28.0	0.190	2.0
Russell Leatherman	219	5.9	1.40	0.73	0.114	23.0	0.200	3.0
Everette Lutz	223	5.7	0.80	0.70	0.136	15.0	0.290	2.6
J. L. Sain	227	6.4	3.50	1.13	0.080	17.0	0.235	2.8
B. H. Greigg	231	5.9	1.05	0.52	0.290	38.0	0.200	2.2
D. Rush Beam	235	5.9	1.05	0.58	0.077	12.0	0.185	2.1
B. G. Leatherman	239	6.7	8.00	1.68	0.052	3.0	0.190	2.0
Total		55.1	30.70	9.42	1.515	273.0	2.120	23.0
Average		6.12	3.411	1.047	.1683	30.33	.2356	2.56

The Analytical Analysis of Subsoil Collected In Row Middles in Cleveland and Lincoln Counties in 1957

Orchard Owner	Sample Number	pH	Ca	Mg	Mn	P	K	O.M.
			me/100g	me/100g	me/100g	ppm	me/100g	me/100g
John Richardson	208	5.7	0.80	0.54	0.420	3.0	0.210	1.0
J. D. Elliott	212	6.4	8.00	1.48	0.170	43.0	0.285	3.6
Cameron Ware	216	5.6	0.80	0.56	0.009	2.5	0.185	0.9
Russell Leatherman	220	5.4	0.70	0.50	0.100	8.0	0.185	1.5
Everette Lutz	224	5.5	0.70	0.47	0.114	5.0	0.235	1.3
J. L. Sain	228	6.7	1.30	0.82	0.054	7.0	0.185	1.3
B. H. Greigg	232	5.6	0.70	0.03	0.320	21.0	0.190	1.8
D. Rush Beam	236	5.4	0.70	0.20	0.065	6.0	0.175	1.1
B. G. Leatherman	240	6.3	6.40	0.56	0.049	13.0	0.170	1.0
Total		52.6	20.10	5.16	1.301	108.5	1.820	13.5
Average		5.84	2.233	.573	.1446	12.05	.2022	1.50