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Bulletin No. 241 - Peach Harvesting Studies

F. M. Coe

BULLETIN 241 APRIL, 1933

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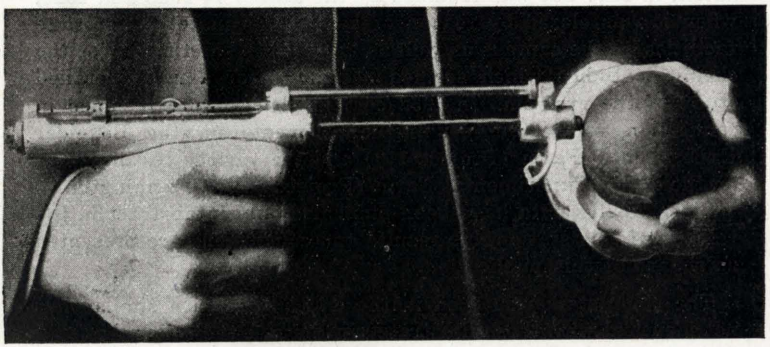


THE PRESSURE TEST: Showing method of testing peach fruits with the California pistol-grip tester with 5/16th-inch plunger. The pressure tester measures the resistance in pounds of the peach to penetration by the plunger as a measure of ripeness. This test is based on the softening of the flesh as maturity increases.

UTAH AGRICULTURAL EXPERIMENT STATION
UTAH STATE AGRICULTURAL COLLEGE
LOGAN, UTAH

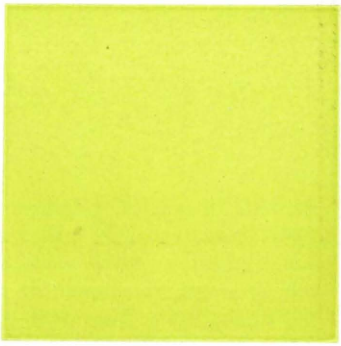
FOREWORD

The experimental work upon which this report is based was initiated in 1925 by T. H. Abell, Assistant Station Horticulturist. The season of 1925 was taken up with preliminary work, such as formulating color standards and making preliminary tests which were later used in the main experiments. In 1926 Abell harvested and tested peaches from seven orchards in Davis, Weber, and Boxelder Counties and held them in storage to test their transportation qualities. The work was interrupted by Abell's resignation in 1927 but was resumed by the author in 1928 and 1929, when it was closed by reason of lack of adequate cold-storage facilities on the campus as well as lack of time and funds for the chemical studies which seemed necessary for a more detailed study of the problem. In 1932 certain phases were resumed in connection with peach-pruning experiments on the Boxelder Experimental Farm (Project 119) and the variety testing work on the Davis Experimental Farm (Project 95) at Farmington.

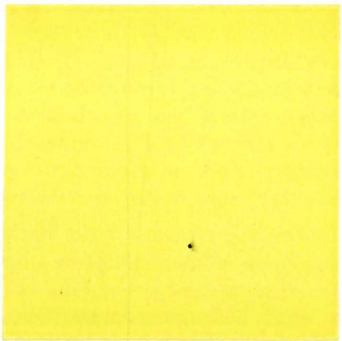
Since Abell's data have been published only in abstract in the reports of this station, his results and conclusions are presented as a part of this publication.

The color standards used in the experiments are similar but not identical with those illustrated in Plate 1, the originals being in water colors from peaches by H. Ruben Reynolds of the Art Department, Utah State Agricultural College. The colors shown in Plate 1 are similar to the originals in hue but are of uniform intensity and value, and represent uniform gradations in hue, from green to orange, similar to those shown by Elberta type peaches at various stages of maturity. The standard colors were selected from "A Dictionary of Color," by Maerz and Paul. The names for Colors 3 to 6 are standard names; Colors 1 and 2 are termed green and greenish yellow since no standard names are given by Maerz and Paul.

1
GREEN
Plate 18-J-4

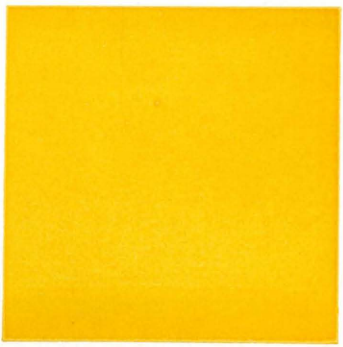


2
GREENISH-YELLOW
Plate 18-J-2



3
SULFUR YELLOW
Plate 10-J-1

4
AMBER YELLOW
Plate 10-J-3



5
CORN YELLOW
Plate 10-J-5

6
MIRABELLE
Plate 10-J-7

PLATE 1—PEACH HARVESTING COLOR STANDARDS

Color standards as well as names of Colors 3 to 6, inclusive, have been selected from the text, "A Dictionary of Color," by A. Maerz and M. R. Paul. Numbers used refer to standard colors used. No standard names are listed for Colors 1 and 2;

SUMMARY

1. The purpose of the four seasons' study of maturity indexes of Elberta type peaches, made in Utah during the years 1926, 1928, 1929, and 1932 and presented in this publication, was to determine more accurately the best stage of maturity of peaches for distant shipment. In general, the procedure was: (1) To record color, pressure test, and other maturity indexes of fruit from trees under various conditions of culture, age, and vigor; (2) to classify the fruit by size and ground color; (3) to store under conditions comparable to refrigerated shipment to market; and (4) to record the appearance, quality, and condition of fruit when withdrawn from storage. Elberta, Early Elberta, and J. H. Hale varieties were investigated. In 1932, maturity indexes were studied in their relation to pruning methods, precooling, and chemical content of fruit.

2. While there was considerable variation in **pressure tests** and **ground color** under different conditions and seasons, these indexes of maturity appear to be more useful and accurate than any others tested. Pressure tests at harvest appear to be more closely related to firmness and condition of fruit on arrival at the market, while undercolor at harvest is more closely related to quality and attractiveness.

3. Range of colors and pressures giving satisfactory quality and condition varied somewhat under different conditions of tree vigor and shading, as well as under weather conditions preceding harvest. Fruit from trees of moderate vigor with good exposure to sunlight, such as resulted from "long" or "thinning-out" pruning, was generally satisfactory when picked at a pressure test range of 12 to 18 pounds (unpeeled cheeks with $\frac{5}{16}$-inch plunger) and from Color No. 3 (sulfur yellow) to between Colors Nos. 3 and 4 (sulfur yellow to amber yellow). (See color chart, Plate 1.)

4. Fruit from highly vigorous trees with dense tops and shaded fruiting wood, such as resulted from heavy heading-back pruning, was most satisfactory when picked at 15 to 18 pounds' pressure and with Colors Nos. 2 and 3 (greenish yellow and sulfur yellow). Fruit from this type of tree was usually less attractive in color, fuzzier, lower in sugar content, and often of poorer quality than fruit from trees of more moderate vigor and better exposure of fruit and fruiting branches to sunlight.

5. Fruit from weakly vigorous trees with a high degree of exposure to sunlight of fruit and fruiting twigs (such as unpruned trees) may be picked at both higher and lower pressure tests and color than is possible with fruit from densely vegetative trees, and still develop satisfactory quality and remain in good condition. Fruit of this type was satisfactory over a range of 12 to 20 pounds' pressure and Colors No. 3 and 4 (sulfur yellow and amber yellow). It is difficult to secure the desired size of fruit, however, on such trees of low vigor.

6. Fruit of a somewhat riper stage than described in the preceding paragraphs developed both better quality and a more attractive appearance

but was generally softer than desired by the wholesale trade for rehandling; in many cases it showed considerable bruising or decay. Such fruit when precooled, so as to reduce the temperature to below 50° F. promptly without the usual delay of 60 to 72 hours in an iced-car loaded with warm fruit, remained in a satisfactory condition and was more attractive and better flavored than less mature fruit handled in the ordinary manner.

7. Early Elberta peaches were generally best when picked at a pressure range of 14 to 18 pounds and with a color between Colors Nos. 2 and 3 (greenish yellow and sulfur yellow) and Color No. 3 (sulfur yellow). Fruit of Color No. 4 (amber yellow), although developing better color and quality, was too soft when handled by ordinary delayed refrigeration but was satisfactory when precooled.

8. J. H. Hale peaches, because of their greater firmness, may be picked at a somewhat more advanced stage of ripeness than Elberta and Early Elberta. The best pressure test range was 12 to 17 pounds with Colors Nos. 3 and 4.

9. Although peaches became more freestone with advancing maturity, the "freedom-of-pit" test did not prove as reliable as the color and pressure tests because of variation between orchards, many crops passing the optimum picking stage before becoming entirely freestone. Little change in degree of clinging appeared to accompany ripening off the tree. No consistent correlation was apparent between freedom of pit and color of fruit of the same picking.

10. There was a significant negative correlation between ground color and pressure tests with both Elbertas and Early Elbertas.

11. Flesh color, like skin color, increases as maturity advances. Flesh is more highly colored than skin in the greener stages of ripening but is nearly equalled by the skin color when the peach is fully ripe.

12. No consistent differences in firmness, pressure tests, or storage quality was apparent between different-sized peaches of the same color and firmness before storage.

13. The amount of red color on the three varieties increased markedly as harvesting was delayed. In 1932 the percentage of fruits meeting the minimum color requirements of the U. S. Fancy Grade (25 per cent red color) increased 26 to 58 per cent, respectively, with five days' delay in picking. The amount of red color in lots of the same ground color was lower in the later pickings.

14. Sugar content increased markedly with delay in harvesting. This increase was mostly sucrose. In 1932 increase in total sugars ranged from 16 to 25 per cent in five days.

15. Delay in harvesting as compared with "green picking" resulted in marked increases in size and yield. Peaches continue to grow in size until they are soft ripe. In 1932 measurements during 4 weeks preceding harvest showed an increase in diameter of 39 per cent and in volume of 125 per cent. From the first to the third picking the average diameter increased 13 per cent and the calculated volume 42.8 per cent.

Peach Harvesting Studies[1]

Francis M. Coe[2]

CONTENTS

INTRODUCTION

Quality and appearance are the most important factors affecting the sale and consumption of fresh peaches. Large, well-colored fruit in firm ripe condition brings the highest prices. That color, firmness, and dessert quality are largely determined by the degree of maturity at harvesting is universally recognized. However, growers, buyers, and marketing experts do not agree either as to the exact stage of maturity which will give the quality and condition desired or as to the best means for determining this stage of maturity. In order to be on the safe side and avoid losses from over-maturity, the tendency with shippers has been to ship fruit too green for the development of satisfactory dessert quality.

On the other hand, large losses have often been sustained by harvesting at a too-advanced stage of ripeness, especially in the latter part of the harvest season. There is need for more accurate information on the most desirable stage of maturity for peaches for shipment as well as for more accurate ways of determining this stage of maturity. Experimental work reported here was undertaken with a view to furnishing information on this problem, particularly as to more accurately determining the best stages of maturity for harvesting Elberta type peaches from orchards of the intermountain region for shipment to middle-western and more distant markets.

Acknowledgments: Credit is due T. H. Abell for the initiation of these experiments, for the 1925 and 1926 data, and for formulation of the color standards used. The assistance of Professor H. Ruben Reynolds of the Art Department of the Utah State Agricultural College in the preparation of the color standards is gratefully acknowledged. Credit is also due Director P. V. Cardon and former Director William Peterson for assistance in formulating the experimental procedure; to Dr. A. L. Wilson for assistance with the chemical work; to Mrs. Blanche C. Pittman for assistance with the manuscript; to Mr. Arvil Stark for assistance with the experimental work in 1928 and 1932, and to Mr. Robert K. Gerber for assistance with the graphs, and field and chemical work in 1932; the generous cooperation of the Utah Ice and Storage Company in donating cold-storage space is also gratefully acknowledged.

[1]Contribution from Department of Horticulture, Utah Agricultural Experiment Station.
[2]Assistant Horticulturist.
Report of State Project 86: Peach Harvesting Indexes.
Publication authorized by Director, February 20, 1933.

REVIEW OF LITERATURE

Recommendations on Peach Harvesting

Examination of the literature on peach-growing shows many of the recommendations on picking maturity to be indefinite. Of thirteen such recommendations reviewed, ground color[3] and firmness were mentioned as indexes of maturity in nine, while red color was mentioned or implied in four, judgment and experience in three, and ease of separation from the twig in one. In order to bring together the published recommendations on peach harvesting, the essential portions of these recommendations are quoted here in chronological order:

Smith (1895) says: "There is just the right time to pick for market, and this is something to be learned by experience—a day too early and the peaches are green, a day too late and they are overripe and will be soft and bruised and unsalable before they reach the consumer. No fruit requires greater expedition and better judgment in picking and marketing."

Waugh (1905) states: "Peaches and apricots are picked as soon as they show the first traces of ripening. The well-trained picker tests each fruit by taking it between his thumb and fingers, and feeling of it with the ball of his thumb. The fruit is not squeezed nor bruised; but if it has the faintest feeling of mellowness its time has come, and the picker transfers it to his basket."

Walker (1909) at the Arkansas Station says: "An experienced picker can tell at a glance when the fruit is in the proper condition. The greenness on the lighter side has barely disappeared. The fruit should never be pressed with the thumb point to determine its ripeness."

Close and Ballard (1911) in Maryland recommend: "For distant shipment the fruit must be picked while still firm but should be fully grown and well colored. The grower must endeavor to have it reach the market just as it is in condition to use. For local marketing it may be allowed to begin to ripen on the trees."

Barden and Eustace (1913) at the Michigan Station state: "For shipping to distant points, the fruit must be picked when firm, but should have its full size and be colored as much as possible."

Hedrick (1916) in his "Peaches of New York" mentions firmness to the touch and yellowish green to lemon or orange yellow color as indexes to maturity.

Smith (1916) in Ontario, Canada, says: "For successful shipment of precooled peaches the fruit must be picked when medium-ripe, i. e., when the fruit is mature yet not ripe. With the Elberta peach this stage is reached when the ground color is turning yellow and the blush is advancing to a good splash of red, yet when the fruit is perfectly firm. This is usually two or three days before the peach would be ripe if left on the tree . . . . . If allowed to be placed under refrigeration when ripe, contrary to common opinion, its quality becomes mealy, dry, and worthless. On the other hand, if picked too green it will never advance in color, quality or flavor."

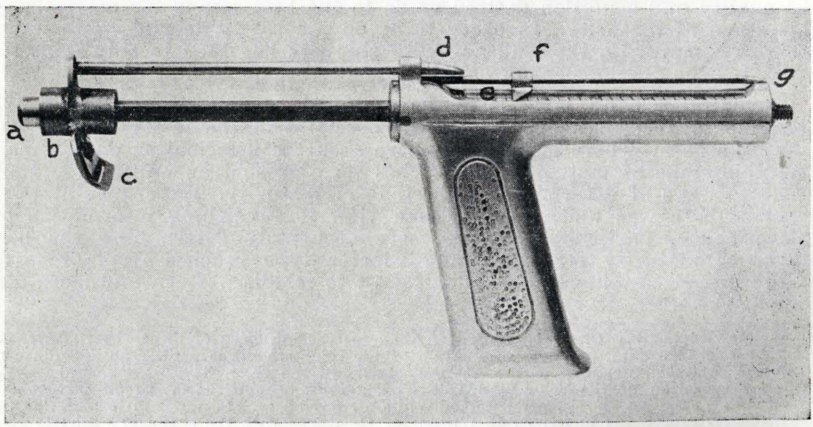


Figure 1—California Pistol-Grip Pressure Tester—Plunger (a) penetrates fruit to collar (b) compressing spring, which is adjusted by nut (g). The pointer rod (d) pushes rider (f) along scale of pounds (e) so that pressure may be read after releasing plunger. Pressure must be gradually and evenly applied or rider will be propelled too far by sudden impact, giving too high readings. Blade (c) is for peeling off skin for tests on peeled surface. (Courtesy Calif. Agr. Exp. Sta.)

[3]The green and yellow undercolor as distinguished from the red overcolor.

Gould (1918) recommends the following: "The most favorable degree of maturity for long distance shipment is that termed hard ripe. In this condition the fruit has lost the solid, unyielding hardness characteristic of the green stage, yet it is firm to the touch, not having begun to soften as in the later stages of ripening. The picker must learn to recognize this hard ripe condition by the eye rather than the touch . . . . . When a fruit begins to lose what is sometimes called its chlorophyll green, that is, the green color which is like the green of the leaves in quality though not in intensity, and to assume a yellowish tinge in case of a yellow variety, or a creamy white shade in case of a white variety, then it has reached the degree of maturity for long distance shipment or for holding a relatively long time. When the fruit has reached the condition indicated by change of color, the stem will separate quite readily from the tree, whereas the articulation of stem and spur does not break easily nor freely prior to the beginning of maturity."

Price and James (1922) at the Mississippi Station state: "Where long shipping is practiced, the peaches should be removed from the tree just as soon as they are fully matured, the blush has developed, and the deep growing green has disappeared."

Duruz (1922), in California, recommends: "Peaches for eastern shipment should be hard ripe at picking time . . . . . Yellow fleshed peaches, when ready for picking, should show the under color changing to yellow or golden yellow. Peaches are never picked according to firmness as determined by pressure of the thumb or hand."

Samson (1922) says: "The condition of the fruit upon arrival in the market depends largely upon the stage of maturity at which it is picked and upon the care with which it is handled. The peach ripens so quickly that in two or three days it will advance from a stage which is so immature as to affect the edible quality to one which is too far advanced for shipping, and for that reason the determination of the proper stage of maturity is especially important. Indeed, there is no consideration of greater consequence in determining the market value of the fruit, but in spite of this fact few growers manage to pick their peaches uniformly at the proper stage . . . . . Pick the fruit approximately 48 hours before it reaches the proper maturity for eating. One sign that the fruit is about ready to pick is the change in the ground color from the green color indicative of immaturity to a light yellow in the case of yellow-fleshed varieties."

Fraser (1927) states: "Yellow-fleshed varieties are usually gathered when the fruit has colored on one side and is a yellowish green to orange yellow on the under side and while still firm."

Talbert and Hooker (1927) in Missouri recommend that "peaches for long distance shipment should be picked when the fruit is firm to the touch and before it has begun to soften as in later stages of ripening. When the fruit begins to lose the green color and to assume a yellowish tinge or a creamy white shade, depending on the variety, it has then usually reached the degree of maturity required for profitable marketing."

Overholser and Duruz (1930), in California, call attention to the increase in weight of fruit and in sugar content during the ripening period, citing a 12 per cent increase in weight and urging that harvesting be delayed as long as possible and yet arrive on the market in good condition. In regard to maturity indexes, they state: "When suitable for market the fruit is fully developed and almost fully colored. The flesh is firm and will withstand handling. When fully ripe the peach is well colored and the flesh is soft and so easily bruised that it will not withstand shipping . . . . . Under California conditions for long distance shipment, the peaches are picked somewhat more immature than is desirable for local markets."

Previous Experimental Work

Bigelow and Gore (1905), studying the chemical composition of a number of varieties of peaches at different stages of growth and ripeness, found that peaches increased in weight 8.93 grams per fruit, or nearly 12 per cent of the weight, from the time of market ripeness to full ripeness. On account of this increase in weight they suggest that peaches should be allowed to remain on the tree as long as possible without sacrifice to their keeping and shipping qualities. They found that between the periods of market ripeness and full ripeness (five days), the percentage of sugar increased from about 53 per cent (calculated as percentage of total solids) to practically 60 per cent, while the percentage of marc (insoluble matter) decreased from 18.35 per cent to 14.28 per cent. In the Elberta variety alone, total sugars increased from 56.27 to 59.96 per cent, acid decreased from 3.34 to 2.89 per cent, and marc decreased from 18.71 to 12.80 per cent during this period. The sugar increase was in sucrose, as the reducing sugars decreased 2.27 per cent.

Morris (1927) found the plunger type of pressure test to be less satisfactory than a flattening test made by compressing the fruit between two flat surfaces and measuring in pounds the amount of pressure required to reduce the diameter one-eighth inch. With this test he found fruit between 12 and 18 pounds' pressure to be best; when the pressure was over 18 pounds, fruit colored but developed poor quality. Because of the suddenness of the drop in pressure, Morris gave up the pressure test as being of "little or no value in work with this fruit." He recommended the use

of color as the best maturity index, giving "light orange color around the red cheek but firm at harvest" as the stage of maturity giving the best quality and standing up well in handling and shipment. He also pointed out that color did not develop normally in cloudy, rainy seasons, quality and condition being less satisfactory under these conditions.

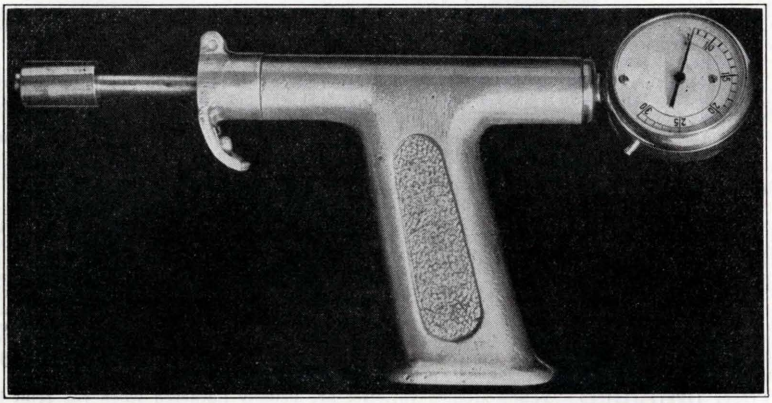


Figure 2—Hydraulic Pressure Tester—Plunger operates in cylinder of oil. Pointer registers number of pounds' pressure on dial until released. Will not test fruit below 7 pounds.

In a later publication, Morris (1932) presents results of five years' harvesting and storage experiments in Washington. He concludes that neither color nor pressure test alone is adequate as a maturity standard, but that a combination of these two seems to be the best method of arriving at a standard or gauge to use in harvest work. He does not give definite color and pressure test standards, however, as indicating the proper stage of ripeness for distant shipment, nor did he attempt to define the limits of color and pressure within which suitable quality and condition may be attained, stating that "it has not been possible to designate certain fixed color lines as the basis for selection of fruit for satisfactory picking on account of variations in this factor caused by variations in vigor, load of fruit, weather, and other factors. His data indicate, however, that normally colored fruit with a pressure test range of 12 to 18 or 20 pounds (on the unpeeled cheeks) and a light yellow to deep yellow ground color on the darkest side gives the best commercial condition and quality; the riper lots, with a pressure range of 7 to 15 pounds and with a ground color deep yellow to light orange around a crimson cheek, gives the highest quality. However, such peaches were usually too soft for the normal commercial rehandling which awaits a car of peaches on arrival in the terminal markets.

Morris further concludes that neither form of fruit nor ease of separation can be used as indexes of maturity.

Blake (1928) reports experiments with a needle-plunger tester (plunger measuring .032 inch diameter), a $\frac{3}{16}$-inch plunger tester, and a $\frac{5}{16}$-inch plunger tester. He concluded that the needle tester is most suitable for work on very immature fruits, while the larger testers work better on maturing fruits. He preferred the $\frac{5}{16}$-inch tester, testing with the skin on, since skin toughness is a contributing factor in enabling the fruit to resist packing and transportation pressures without injury. His tables of comparative readings show the $\frac{5}{16}$-inch plunger to read approximately double the readings of the $\frac{3}{16}$-inch plunger and somewhat higher than this in the greener fruit. Comparison of tests with the $\frac{5}{16}$-inch plunger on peaches with and without the skin showed the fruit tested with the skin on to run from 2.5 pounds higher on the ripe fruit to 6.4 pounds higher on green fruit than

the same fruit tested with the skin off, the skin accounting for 73 per cent of the pressure resistance on soft ripe fruit, 55 to 60 per cent on firm ripe fruit, and 45 per cent on green fruit.

Blake further points out the impracticability of a single pressure standard for all varieties and for trees of different "growth status." Similarly, he asserts that color standards do not apply the same to all varieties, some varieties softening while green; others, such as the J. H. Hale variety, remain firm when fully colored.

Blake (1929) published a description of a pressure tester devised by him especially for peaches which uses a $\frac{3}{16}$-inch plunger and is designed for use on the unpeeled surface of the fruit. He suggests the following pressures as maturity indexes: 3.5 to 5 pounds—home or nearby fruit stand; 5 to 6 pounds—nearby markets; 6 to 7 pounds—short-distance shipping; 7 to 8 pounds—medium-distance shipping; and 8 to 9 pounds—long-distance shipping. These pressures are for tests made through the skin of the peach.

Blake and Davidson *et al.* (1931) studied flesh texture in relation to the carrying and edible qualities of peaches, while Addoms *et al.* (1930) and Nightingale *et al.* (1930) studied the histology, microchemistry, and macrochemistry of the same lots of fruits in the most complete study which has been published to date on growth and maturation changes in the peach. They used fruit from two Elberta trees of widely different "growth status": One, referred to as "high carbohydrate", or "C", was weakly vigorous with small leaves and short shoots, low in nitrogen, and high in carbohydrates; the other, referred to as "high nitrate", or "N", had vigorous shoots and large leaves, was high in nitrogen and low in carbohydrates, with the fruit heavily shaded.

Fruits from "C" trees were smaller, firmer at the same stage of development and ripeness, ripened earlier and more uniformly, had more red color; the color changes incident to maturity were normal, making the ideal shipping condition readily observable. For this type of fruit, which possessed markedly superior marketing color and edible quality, a pressure test of 8 to 9 pounds was recommended as indicating the right maturity for distant shipment. Fruits from "N" trees became soft ripe nine days later, were larger, lower in sugar content (7.22 per cent as compared to 9.07 per cent for the "C" fruit when soft ripe), the undercolor remained greenish until after the shipping stage had passed, had little red color, ripened unevenly, and never really attained attractive marketing color even when allowed to become soft ripe on the tree. Blake and Davidson conclude that the color test, while useful with high carbohydrate fruits, is deceptive on high-nitrate fruits and that high-carbohydrate fruits may be picked firmer than high-nitrate fruits and still possess good quality and color.

They attempted to use hydrometer tests of juice as an index of maturity but concluded that this test was not sufficiently sensitive, although the juice showed a general increase in specific gravity as the fruits matured.

Nightingale *et al.* (1930), studying the chemical changes in the same experiment, make the following significant statement in regard to accumulation of sugars in the ripening peaches: "It will be sufficient . . . to call attention to the comparatively early accumulation of sugar in fruits "C," which, in a large measure, make possible the maturation of high quality fruits even though they were picked from the tree before the soft ripe stage, whereas similar early picking of peaches from the high-nitrogen tree resulted in fruits of very poor quality." They also found much more tannin in green fruits from "C" trees than from "N" trees. When soft ripe, the tannin contents were about the same. Since bitterness is associated with or is due to the tannin content, this result explains the bitterness of fruits picked green.

Addoms (1930), in connection with the studies of Blake, Davidson, and Nightingale (1931), studied the histology and microchemistry of developing peach fruits of the same "high-carbohydrate" and "high-nitrate" trees.

She found that the yellow ground color of the fruit was due to a carotinoid pigment, while the red color is due to the presence of an anthocyanin pigment. The yellow pigment is distributed in small irregular cytoplasmic inclusions which are especially numerous around the nucleus. They are not evident until the chlorophyll disappears. Addoms was unable to determine whether they are disorganized chloroplasts or are newly formed as the chloroplasts disintegrate.

Addoms found ripening to be associated with a steady decline in thickness of the cell walls, while Nightingale showed this to be accompanied by a decline in percentage of cellulose, hemicellulose, and protopectin. As the fruits become soft ripe, the cell walls become extremely thin and are often broken, so that the cell contents exude, forming the watery areas in the flesh of melting-fleshed varieties, such as Elberta. This does not occur with the canning cling type of peach, in which the cell walls are thicker and remain intact. She found that the outer layers of cells of the flesh are the last to become thin-walled, allowing the skin to "peel." This also does not occur with the canning cling type of peach.

PART I: EXPERIMENTS IN 1925 AND 1926[4]

Objects of Experiments

The object of the 1925 and 1926 experiments was to determine accurate indexes for the picking of peaches for long-distance shipment. Obviously, the advantages of having such an index or indexes would be: (1) Certainty as to the quality of the fruit; (2) uniformity of the product shipped from different orchards; (3) avoidance of losses due to over-ripeness; (4) elimination of the undesirable effects of green peaches on the markets; and (5) an aid to inspectors in determining the quality of fruit, thereby strengthening the dependability of certified grades.

Procedure

The 1925 season was devoted to preliminary tests and to formulating the color standards described under the 1926 experiments (Plate 1).

Orchards and Varieties in 1926 Experiment. Studies in 1926 were limited to Elberta and Early Elberta at that time the principal shipping varieties in Utah.

Seven orchards were selected which represented young and old trees, a variety of soils, slopes, culture, irrigation, pruning, and yields. The conditions and treatments existing in each orchard are tabulated in Table 1. It was believed that this wide variation would indicate whether indexes vary with conditions or are uniform with the same variety under all conditions. These seven orchards were distributed as follows: Two near Brigham City, one at North Ogden Cove, two on the sand ridge south of Ogden, one on South Farmington Bench, and one at Woods Cross.

Method Used. Beginning about one week before commercial harvest was started, each orchard was visited and two or three representative trees of each variety were selected and marked. These trees were visited twice a week until the fruit was soft ripe; samples of fruit were picked, tested, and placed in storage. In picking samples, fruits of all stages of ripeness from all positions on the trees were chosen.

Samples for testing consisted of 15 peaches representative in size, color, and apparent maturity. Each peach was tested for size, color, hardness, and freedom of pit. The size of each peach represents the minimum diameter from cheek to cheek.

The color of each peach was determined by comparing the *uncolored cheek* with a color chart (Plate 1).

[4]Part I—Experiments in 1925 and 1926—has been summarized from Abell's annual report (1926-27) on this project. The arrangement of tables and graphs and part of the discussion are by the author.

Table 1—Elberta and Early Elberta: Cultural notes on peach orchards used in 1926 harvesting experiments.

Orchard	Slope	Soil	Culture	Fertilizer	Irrigation		Pruning	Terminal Growth (inches)		Shipping Dates 1926	Yield per Tree (bu.)	Age of Trees (years)	Growth[a] Status
					Furrows	Frequency		Elberta	Early Elberta				
Beecher[b]	N.W.	Sandy gravel very stony	Clean	Manure every 3 years	1	6 days 3 days during harvest	Very light	2-4	1-4	Aug. 24	3+	15+	High Carbohydrate
Knudson	S.W.	Fine sandy loam	Alfalfa in Elbertas; Weeds in Early Elbertas	None	2	6¾ days	Medium heavy	6-12	6-15	Aug. 20-27	1½-2	7	Medium Carbohydrate
Campbell	S.	Black silty loam slightly stony	Clean	Manure	2	5½ days	Elberta-medium heavy; Early Elberta-light thinning	2-4	6-12	Aug. 24-31	4	Elberta 18 Early Elberta 7	Medium to high Carbohydrate
Jacobs	E.	Sandy silt loam—stony	Weeds	None	2	7 days	Medium	8-12	....	Aug. 26-31 to cannery	3+	7	Medium Carbohydrate
Brown	W.	Sand	Alfalfa	None	2	4 times	Medium	6-10	....	Aug. 27 to Sept. 14 to cannery	3+	15+	Medium Carbohydrate
Ford	S.W.	Sandy loam gravelly	Clean	None	1	Mostly before 6-1	Elberta-medium; Early Elberta-very light	4-10	2-6	Aug. 21-27	½ to 1½	15+	High Carbohydrate
Odell	W.	Sandy loam stony	Clean	None	2	10-14 days	Very heavy resulting in heavy shade	15-20	20-22	Aug. 22-28	2	15+	High Nitrate

[a]Term suggested by Blake (1929) to denote vigor of growth. Notes in this column are by author.

[b]Considerable damage from peach borer evident.

The hardness of each peach was tested with the improved pressure tester developed by Magness and Taylor (1925) (Fig. 3). The $\frac{5}{16}$-inch plunger was found most satisfactory. Pressure tests were made on the unpeeled surface of each peach as follows: On each cheek, on the cheek beside the suture, and on the opposite edge. These tests were then repeated on the peeled surface. An attempt was also made to test some peaches with an inch-ball attachment, but pressure required was so great on the peaches in the earlier stages of ripeness that this test was abandoned.

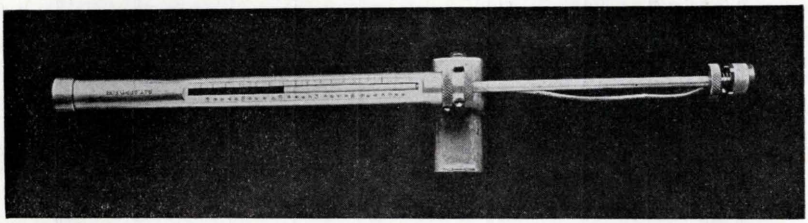


Figure 3—U. S. D. A. Pressure Tester—Plunger is attached to cylinder which compresses a spring. Pressure is read from scale when collar behind plunger is forced back, making contact with base and lighting flashlight lamp with battery circuit. This type of tester was used in the 1926 and 1928 experiments. (Courtesy Calif. Agr. Exp. Sta.)

Both orchard men and buyers are accustomed to use the freedom-of-pit test to determine ripeness; hence, this test was used on each peach. This consists in cutting around the peach through the flesh transversely to the axis of the pit, then twisting the two halves until one-half comes free.

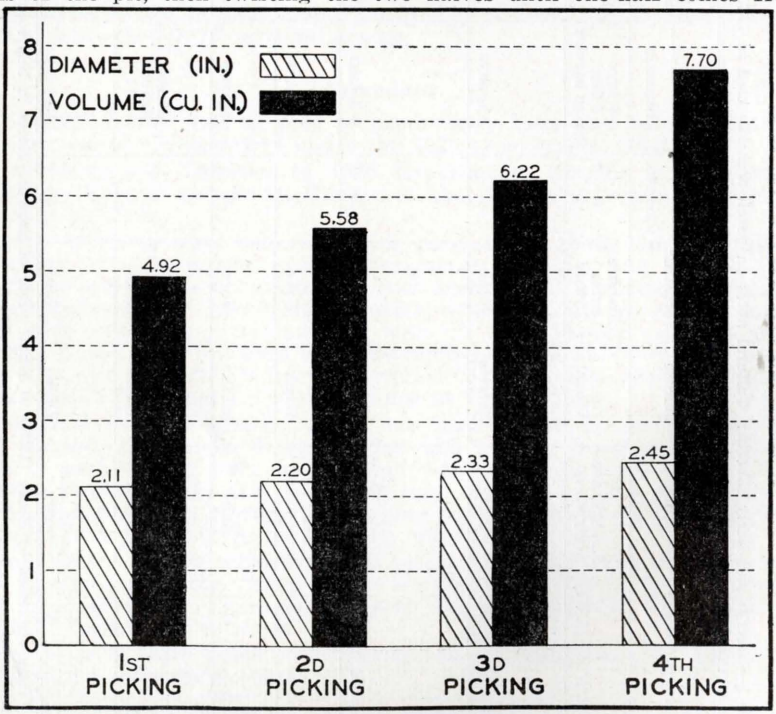


Figure 4—Increase in Size of Elberta Peaches During Harvest—Knudson, Brown, Odell Orchards, 1928. Shaded bars represent average diameters of peaches of each picking; black bars represent volume calculated as spheres of the same diameter.

When the flesh separates cleanly from the pit, the peach is supposed to be ready for shipment.

Storage. Samples for storage were placed in standard half-bushel round stave baskets. Peaches were protected with regulation corrugated paper caps under covers. Baskets were stored, usually the same day they were harvested, in a commercial storage plant in Ogden; occasionally peaches picked in the afternoon were not stored until the next morning. The temperature was held uniformly at 44° to 45° F. This is approximately the average temperature maintained by the lower layers of peaches in a refrigerator car during transit.

Samples were withdrawn from each basket seven, ten, and fourteen days after being placed in storage. These intervals represent the usual periods which elapse until fruit is placed on the market at Mississippi River points and farther east. These same samples were placed in paper bags and carried over fairly smooth roads by automobile to Logan, a distance of 50 miles, where they were set out on tables in the laboratory for observation seven to ten days. Within 24 hours after arrival a sample of each was tested for color, pressure, flavor, bruises, and percentage of decay.

Presentation of Data and Discussion of Results

A brief examination of Figures 4, 5, 6, 7, and 8 shows, as the fruit ripens[5], how uniformly the size of the peaches increase, the color changes from green to orange, and the pressure tests decrease.

After all data were secured, the "Best Picking" from each orchard was chosen on the basis of the best flavor combined with the least spoilage on withdrawal from storage.

Size Increase during Harvest. Data on increase in size during the harvest season for the six orchards studied are summarized in Table 2.

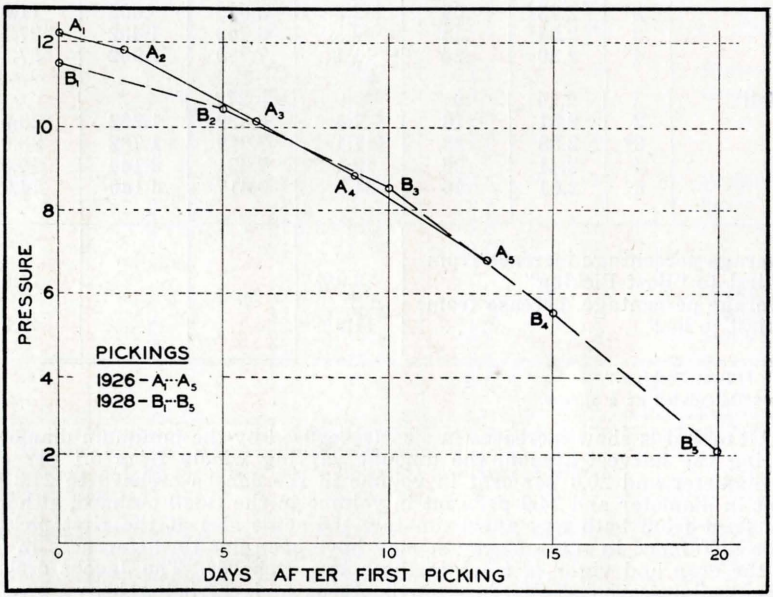


Figure 5—Comparative Pressure Test of Elberta Peaches for 1926 and 1928—1926 Pickings: A_1 to A_3; 1928 Pickings: B_1 to B_3. Pressure is in pounds for tests on peeled suture. Note close similarity in curves for the two seasons. The rate of softening increases as maturity advances. The third picking was the best picking.

[5]While Figures 4 and 6 represent 1928 data, 1926 results were similar.

Table 2—Elberta: Increase in size of peaches during harvest season (1926).

Orchard	No. of Picking	Average Diameter of Peaches (in.)	Total Increase in Diameter (in.)	Percentage Increase in Diameter (%)	Volume** (cu. in.)	Increase in Volume (cu. in.)	Percentage Increase in Volume (%)
Beecher	1	2.08	0	..	4.712	....	....
	2	2.06	0	0	4.578	0	0
	3*	2.18	.10	4.8	5.425	.713	15.1
	4	2.13	.05	2.4	5.132	.420	8.9
	5	2.23	.15	7.2	5.885	1.173	24.9
Knudson	1	2.21	0	..	5.729	....	....
	2*	2.24	.03	1.3	5.885	.156	2.7
	3	2.36	.15	6.7	6.883	1.154	20.2
	4	2.45	.24	10.8	7.795	2.066	36.1
Campbell	1	2.00	0	..	4.189	....	....
	2	2.00	0	..	4.189	0	....
	3*	2.08	.08	4.0	4.712	.523	11.9
	4	2.13	.13	6.5	5.132	.943	22.5
	5	2.30	.30	15.0	6.371	2.182	52.1
Jacobs	1	2.14	0	..	5.132	....	....
	2*	2.08	0	..	4.712	0	0
	3	2.11	0	..	4.993	0	0
	4	2.27	.13	6.1	6.206	1.074	20.9
Brown	1	2.16	0	..	5.277	....	....
	2*	2.23	.05	2.3	5.885	.608	11.5
	3	2.34	.18	8.3	6.709	1.432	27.1
	4	2.40	.24	11.1	7.239	1.962	37.1
Odell	1	2.15	0	..	5.277	....	....
	2	2.31	.16	7.4	6.539	1.262	23.9
	3*	2.38	.23	11.1	7.059	1.782	33.0
	4	2.41	.26	12.1	7.421	2.144	40.6
	5	2.61	.46	21.3	9.417	4.140	74.9
Average percentage increase from first to "Best-Picking"				3.9%	....	....	14.8
Average percentage increase from first to last				11.9%	....	....	49.2

*"Best Picking."

**Calculated as a sphere.

All orchards show increases in size (measured by the minimum diameter) during the harvest season, the amount varying widely from 6.1 per cent in diameter and 20.9 per cent in volume in the Jacobs orchard to 21.3 per cent in diameter and 74.9 per cent in volume in the Odell orchard, although the fruit from both was approximately the same size at the first picking. This difference in rate of growth may have been due to differences in size of the crop and vigor of trees in these two orchards. The Jacobs orchard was medium-carbohydrate in growth status and carried a heavy crop of fruit; on the other hand, the Odell orchard, which was heavily pruned, was of a high-nitrate type and carried a lighter load. The average increase from the first picking to the "Best Picking" for shipment was 3.9 per cent in diameter or 14.9 per cent in volume; from the first to the last picking was 11.9 per cent in diameter and 49.2 per cent in volume.

Pressure Tests. Pressure-test averages for Elberta orchards studied are given in Table 3, showing their relation to dates of picking, flavor, and spoilage after withdrawal from storage. Pressure-test figures presented are for the following tests: (a) Average of both cheeks with the skin on and (b) on the cheek beside the suture with the skin removed, using the $\frac{5}{16}$-inch plunger in both tests.

Table 3—Elberta: Pressure test, spoilage, and flavor picked at different dates and held at 45° F. for from 7 to 14 days (1926).

Orchard	Picking No.	Date of Picking 1926	Pressure Tests[a]		Average Spoilage[b] (%)	Flavor on Withdrawal
			Cheeks, Skin On	Suture, Skin Off		
Beecher	1	Aug. 18	20.2	12.8	2	Bitter
	2	20	20.1	11.5	5	Poor
	3[c]	24	18.6[c]	10.0[c]	10	Good[c]
	4	27	15.0	8.6	35	.....
	5	31	11.3	6.8	49	.....
Knudson	1	Aug. 18	19.6	11.8	0	Bitter
	2[c]	20	20.4[c]	11.3[c]	10	Good[c]
	3	24	16.7	8.3	24	.....
	4	27	13.4	7.3	46	.....
Campbell	1	Aug. 18	18.9	12.0	0	Poor
	2	20	20.1	11.9	1	Poor
	3[c]	24	17.8[c]	10.8[c]	17	Good[c]
	4	27	16.9	9.9	33	.....
	5	31	12.3	7.2	46	.....
Jacobs	1	Aug. 21	22.3	11.6	0	Bitter
	2[c]	24	21.0[c]	10.7[c]	14	Good[c]
	3	27	17.2	9.3	19	.....
	4	31	11.5	5.3	50	.....
Brown	1	Aug. 21	22.7	13.1	0	Bitter
	2[c]	24	20.1[c]	10.4[c]	5	Good[c]
	3	27	17.5	9.8	14	.....
	4	31	14.7	8.0	35	.....
Odell	1	Aug. 17	20.7	...	2	Poor
	2	21	20.4	11.5	0	Fair
	3[c]	25	19.4[c]	10.8[c]	5	Good[c]
	4	27	15.0	8.1	64	.....
	5	31	12.4	6.6	60	.....

[a]Pressure test figures are for 5/16th-inch plunger on (1) average of both cheeks, skin on and (2) cheek beside the suture with the skin removed.

[b]Average of decay in withdrawals 7, 10, and 14 days after storage.

[c]"Best Picking."

Pressure-test averages for all orchards, on the basis of "Best Picking," are presented in Table 4. The decrease in pressure in the 1926 and 1928 seasons is shown graphically in Figure 6.

Discussion of Pressure Tests. In the 1926 experiments, fruit of the "Best Picking" averages 19.6 pounds, measured on the unpeeled cheeks, and ranged from 17.8 to 21 pounds. Measured on the peeled cheek beside the suture, the range of average pressures of "Best Pickings" was 10 to 11.3 pounds, with an average of 10.8 pounds.

Table 4—Elberta: Comparison of pressure-test averages taken on unpeeled cheek and on peeled suture (1926).

PICKING	PRESSURE TESTS (LBS.)		
	Cheeks, Skin On	Suture, Skin Off	Difference
Before "Best Picking"	21.1	12.1	9.0
"Best Picking" for Distant Shipment	19.6	10.8	8.8
After "Best Picking"	16.5	9.1	7.4

It should be borne in mind, in considering the high tests secured in the 1926 data, that the method of sampling used in 1926 was to pick a representative sample, regardless of the stage of maturity of the individual fruits, which resulted in each lot having a wide range of maturity from immature green fruit to nearly-ripe, highly-colored fruit. Since spoilage was the most important criterion used in the designation of the best pickings, it is probable that in avoiding a high percentage of spoilage, lots were chosen containing a high proportion of harder, greener fruits than would be necessary with a sample of uniform maturity. These greener fruits would give a higher average pressure-test reading. This is a likely explanation for the divergence between the results for 1926 and those from the 1928 experiments, where the "Best Pickings" were lower, averaging 9 to 10.5 pounds' pressure test (on the peeled suture).

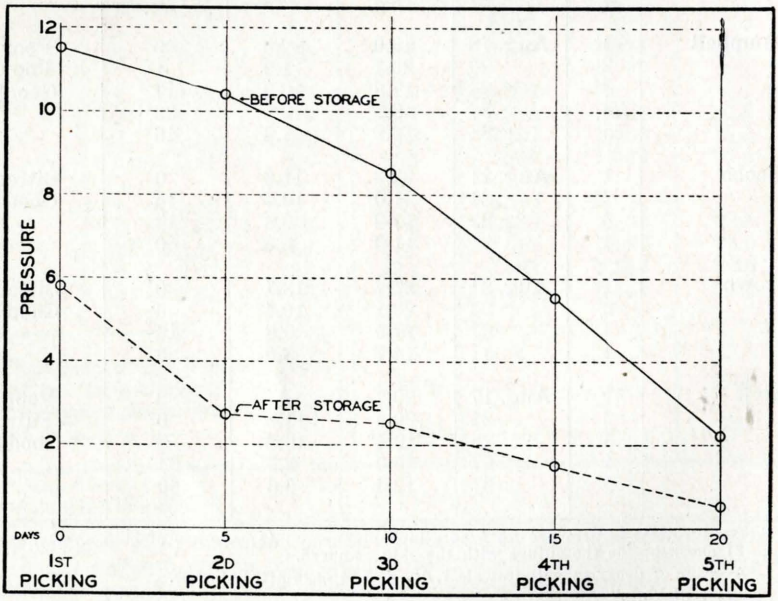


Figure 6—Pressure Tests of Elberta before and after Storage, 1928—Stored 5 to 7 days at 50° F. Note the greater softening of the greener lots. Pressure given is for tests on peeled suture.

The high percentage of spoilage in several of the lots designated as "Best Picking" (10 per cent in two cases, 14 in another, and 17 in a fourth), illustrates the difficulties encountered in commercial harvesting where only one picking is used. The marked variation in the maturity of

peaches on the same tree makes several pickings necessary if uniform maturity is desired.

Freedom-of-Pit Test. Data on the freedom-of-pit tests are summarized in Table 5.

Table 5—Elberta: Changes in clinging of stone during harvest season (1926).

Orchard	PERCENTAGES OF FREESTONE FRUITS IN DIFFERENT PICKINGS						
	Beecher	Knudson	Campbell	Jacobs	Brown	Odell	Avg. All Orchards
Picking							
1st	33	7	0	69	0	0	12
2d	40	13*	8	100*	40*	14	36*
3d	80*	53	14*	93	60	7*	51*
4th	60	40	53	100	86	40	63
5th	100	..	93	..	..	80	91

*"Best Picking" for distant shipment.

While there is a marked increase in the percentage of fruits which are freestone from the first to the last picking, the great variation in this factor between the different orchards would indicate that this test is unreliable. In the Jacobs orchard all pits were free at the time of best picking for shipment, while in all other orchards pits were not free for several days after the "Best Picking" stage.

Color Test. Percentages of each color in each picking are tabulated in Table 6 and shown graphically in Figure 7.

Table 6—Elberta: Average percentage of each color in each picking on basis of "Best Picking" (1926).

Picking	Color No.*					
	1	2	3	4	5	6
Picking preceding "Best Picking"	52	34	2	11	1	0
"Best Picking" (for distant shipment)	5	16	32	28	16	22
Picking following "Best Picking"	1	3	25	30	25	16

*See Color Chart, Plate 1.

The average "Best Picking" of all orchards contained 32 per cent of fruit Color No. 3 (sulfur yellow) and 28 per cent of Color No. 4 (amber yellow). In five orchards most of the peaches in the best pickings were of the third and fourth colors (sulfur yellow and amber yellow, Plate 1). These peaches had acquired a distinct yellow color and had lost most of the green hue. In lots containing any considerable amount of the fifth and sixth colors (corn yellow and Mirabelle), spoilage was high. This is strikingly shown in Figure 7 in the two right-hand double bars representing percentages of the different colors and spoilage in the last two pickings. The percentage of decay is proportional to but somewhat less than the percentage of Colors Nos. 5 and 6 in these lots. These figures represent averages of fruit from the six orchards studied.

In the Knudson and Brown orchards, the peaches were at the "Best Picking" stage when a large part were of the second color as well as of the third and fourth colors. Both of these orchards were medium carbohydrate in growth status. The Knudson orchard had had medium heavy pruning and had made terminal growths of from 6 to 15 inches, while the Brown orchard grew from 6 to 10 inches. The resultant shading may have been responsible for delayed color development.

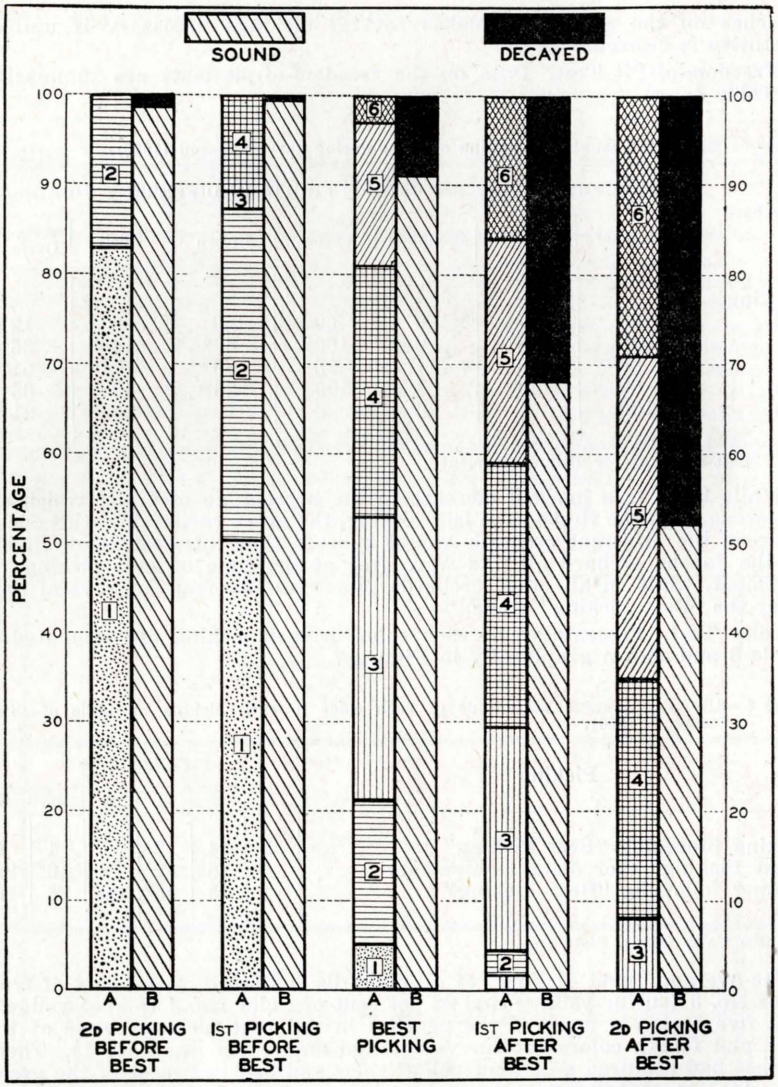


Figure 7—Percentage of Color in Each Picking in Relation to Spoilage of Elberta Peaches, 1926—Numbers in left-half bars refer to ground color (See color chart, Plate 1). Right-hand bars indicate condition; shaded areas represent percentage of fruit in good condition, while black portions represent decay. Note the correlation between spoilage and percentage of orange shades (Colors No. 5, corn yellow, and No. 6, Mirabelle). Fruit of these colors was generally too mature for shipment.

The predominance of the third and fourth colors in the best pickings is even better shown in Table 7, where the percentages of colors are arranged in color groups, combining them as follows: Group 1—Colors Nos. 1 and 2 (the green hues); Group 2—Nos. 3 and 4 (the yellows); and Group 3—Nos. 5 and 6 (the orange hues).

The average of the "Best Pickings" showed 60 per cent of fruits of the yellow group compared with 21 per cent of the green group and 19 per cent

Table 7—Elberta: Average percentages of each color group in the "Best Picking" and pickings immediately preceding and following the "Best Picking" (1926).

PICKINGS	COLOR NOS.*				
	1 ann 2 (Green)	3 and 4 (Yellow)	5 and 6 (Orange)	Flavor	Spoilage (%)
Picking preceding "Best Picking"	86	13	1	Poor	1.3
"Best Picking" (for distant shipment)	21	60	19	Good	10.1
Picking after "Best Picking"	4	55	41	.....	31.5

*See Color Chart, Plate 1.

of the orange group. This indicated: (1) That fruit with a yellow ground color was best for shipment; (2) fruit with a decidely greenish color tended to lack quality when ripened; and (3) fruit with an orange hue was too ripe for distant shipment, being too soft and having a tendency to decay. It is interesting to note here that the percentage of the fifth and sixth colors in each sample is almost exactly the same as the percentage of spoilage in the last withdrawal from storage; hence, it is likely that most of the spoilage was in fruit of these advanced colors. This would indicate further the importance of avoiding Elberta peaches of an orange color for long-distance shipment. In spite of these results many orchards were being picked for shipment in 1926, after the dates of the "Best Picking", as indicated by this experiment.

Relation between Color and Pressure Tests. In the case of the Elberta peach, as would be expected, there is a negative correlation between color and pressure tests of —.767±0.13, the coefficient being 58.5 times as large as the probable error. As will be noted, in Early Elbertas the correlation is —.732±.031, the coefficient being 23.6 times as large as the probable error. These correlations appear to be significant and indicate a high degree of negative correlation between these two tests. That is, the pressure decreases as the color increases, or vice versa. It is possible that in the case of cold rainy weather preceding harvest or heavy shading of the fruit that these correlations would not hold or be as pronounced.

The relation of pressure tests to skin color and flesh color in the 1928 tests is shown graphically for Elbertas, early Elbertas, and J. H. Hales in Figures 8, 9, and 10, respectively. The 1926 data closely resemble those for 1928, which is shown graphically in these figures.

Results with Early Elbertas

Size Increase during Harvest. A summary of the data on increase of size during the harvest season is given in Table 8.

Measured by the minimum transverse diameter, as in commercial grading, Early Elberta fruit did not show as large an increase in size between the different pickings as did the Elbertas. This may be due to the flatter shape of the former or to the shorter ripening period. This variety seems to ripen more rapidly and was picked in three pickings in all but one orchard, while four and five pickings were used in harvesting the Elbertas. The average increase in diameter from the first to the second picking was 2 per cent in diameter or 10.4 per cent in volume; that from the first to the third picking was 9 per cent in diameter, or 32.3 per cent in volume.

Pressure Tests in Relation to Quality and Spoilage. Pressure-test data, together with picking dates, flavor, and spoilage of different pickings after withdrawal, are summarized in Table 9.

Table 8—Early Elberta: Increase in size during harvest season (1926).

Orchards	No. of Picking	Average Diameter of Peaches (in.)	Total Increase in Diameter (in.)	Percentage Increase in	
				Diameter	Volume
Beecher	1	2.20	..	..	...
	2*	2.25	.05	2	9.4
	3	2.28	.08	4	11.3
Knudson	1	2.19	..	..	...
	2*	2.23	.04	2	5.5
	3	2.34	.15	7	20.3
Campbell	1	1.89	..	..	...
	2*	1.83	—.06	3	0.0
	3	1.98	.09	5	13.2
Ford	1	2.14	..	..	...
	2*	2.32	.18	8	27.4
	3	2.42	.20	13	44.6
Odell	1	2.31	..	..	...
	2*	2.39	.08	3	10.7
	3	2.73	.42	18	64.7
	4	2.77	.46	20	72.1
Average	1	2.15	..	..	5.7
All	2*	2.20	.05	2	...
Orchards	3	2.35	.20	9	30.4

*"Best Picking" for distant shipment.

**Calculated as a sphere.

Table 9—Early Elberta: Pressure tests, spoilage, and flavor in relation to time of harvesting (1926) (Held at 45°F. for from 7 to 14 days).

Orchard	No.	Date	Pressure-test Average		Average Spoilage (%)	Flavor on Withdrawal
			Cheeks, Skin On	Suture, Skin Off		
Beecher	1	Aug. 18	21.1	13.0	0	Bitter
	2*	" 20*	16.5	9.6	8	Fair*
	3	" 24	10.7	5.6	45	Good
Knudson	1	" 18	20.5	12.3	0	Fair
	2*	" 20	18.8	10.4	0	Good*
	3	" 24	16.2	8.9	27	.....
Campbell	1	" 18	19.1	11.1	0	Poor
	2*	" 20*	17.9	12.1	1	Fair*
	3	" 24	15.6	7.0	33	Good
Ford	1	" 17	20.7	...	2	Poor
	2*	" 21*	19.6	11.3	12	Good*
	3	" 24	16.7	9.3	28	...
Odell	1	" 17	19.7	...	0	Bitter
	2*	" 21*	17.9	10.1	0	Sweet*
	3	" 25	15.6	7.7	15	.....
	4	" 27	11.0	5.7	61	.....
Picking preceding "Best Picking"			20.2	12.1	0	Poor
Average "Best Picking"*			18.5	10.7	4	Fair to good
Picking after "Best Picking" ...			14.8	7.7	26	Good; heavy decay

*"Best Picking," for distant shipment, based on quality and spoilage.

With the Early Elbertas, "Best Picking" ranged in pressure test from 16.5 pounds to 19.6 pounds, with an average of 18.5 pounds, measured on the unpeeled cheeks. Tests on the suture with the skin off averaged between 10 and 11 pounds' pressure, ranging from 9.6 for the Beecher orchard to 12.1 for the Campbell orchard. This is 1.1 pounds less than the average for Elbertas on the cheek test but practically the same for the suture tests. Two of the "Best Picking" lots ranked only fair in quality, the three others being noted as good or sweet. It is probable that lots harvested or sorted to have a more uniform maturity within each lot would show that fruit with a somewhat lower pressure test would carry satisfactorily and give better quality. Early Elbertas appear, in the 1926 experiment, to be approximately 1 pound lower than the Elberta in the pressure test on the unpeeled cheeks which indicates desired maturity; the same difference was found in the suture test.

Freedom-of-Pit Test. Changes in the clinging of the stone in fruits of Early Elberta peaches during the maturity season are presented in Table 10 as percentages of freestone fruits in the different pickings.

Table 10—Early Elberta: Changes in clinging of stone during the harvest season (1926).

Orchard	Percentages of Freestone Fruits in Different Pickings					Avg. All Orchards
	Beecher	Knudson	Campbell	Ford	Odell	
Picking						
1st	6	60	57	15	80	44
2d*	47*	86*	93*	33*	86*	69*
3d*	73	86	93	67	100	84
4th	..	..	..	..	100	..

*"Best Picking" for distant shipment.

Again, as with Elbertas, there is marked variation in the percentage of fruits showing a freestone condition between the different orchards. Percentages of freestone fruits in the "Best Pickings" vary from 33 to 93 per cent, with an average of 69 per cent. This is a higher percentage of freestone fruits in the "Best Pickings" than that shown by the Elberta data.

Color Test. Percentages of each color in each picking of Early Elberta peaches in relation to the "Best Picking" are summarized in Table 11.

Table 11—Early Elberta: Average percentages of each color in each picking, data from all orchards combined (1926).

Picking	Color No.*					
	1	2	3	4	5	6
Picking Preceding "Best Picking"	7	37	57	0	0	0
"Best Picking" (for distant shipment)	0	32	25	36	6	0
Picking following "Best Picking"	0	0	2	15	49	34

*See Color Chart, Plate 1.

As with Elbertas, a majority or more of the fruit in the best pickings was of the third and fourth colors, a distinct yellow. About a third of the fruit in the "Best Pickings" was greenish yellow.

Table 12 shows the average percentages of peaches of each color in each picking of Early Elbertas combined into three color groups, representing the green, yellow, and orange hues of the color chart (Plate 1).

Table 12—Early Elberta: Average percentages of each color group in the "Best Picking" and pickings preceding and following "Best Picking" (1926).

Picking	COLOR NOS.*		
	1 and 2 (Green)	3 and 4 (Yellow)	5 and 6 (Orange)
Picking preceding "Best Picking"	44	57	0
"Best Picking" (for distant shipment)	32	61	6
Picking following "Best Picking"	0	27	73

*See Color Chart, Plate 1.

In the "Best Picking," the yellow group (Colors Nos. 3 and 4) somewhat predominated, 61 per cent of the peaches in that picking being yellow, with most of the balance being green in color. In the picking preceding the "Best Picking," which was poor to fair in quality, 44 per cent of the fruit was in the green-colored group while 57 per cent was in the yellow group. The picking following the "Best Picking," which proved to be too ripe as evidenced by heavy spoilage, had 27 per cent fruit of the yellow hues and 73 per cent of fruit belonging to the orange group (Nos. 5 and 6). In range of color the Early Elberta fruit resembles the Elberta, except in having a somewhat less green hue in the immature stage and in appearing to color more rapidly after reaching the stage of maturity desired for shipment.

Summary and Conclusions for the 1926 Experiments

(1) The results for 1926 indicate that Elberta peaches were best picked for shipment at an average pressure test of 18 to 21 pounds on the unpeeled cheeks, or 10 to 11 pounds measured on the peeled cheek close to the suture, using the 5/16th-inch plunger. Peaches averaging more than these pressure tests were too green; those averaging less were too ripe. The method of sampling used, however, would give higher pressure tests than where samples of uniform maturity were used.

(2) The 1926 data indicate the desirability of picking Elberta peaches after they have gained a distinct yellow color, corresponding to Colors Nos. 3 and 4 on the color chart (Plate 1) and before they have gained the orange color as observed on the unblushed cheek.

(3) The freedom-of-pit test frequently used did not prove as reliable as the color or pressure tests in the 1926 experiments.

(4) There was a significant negative correlation between the color and pressure tests with both the Elberta and Early Elberta peaches.

(5) The 1926 data indicate that Early Elberta differs but little from Elberta in both color and suture-pressure test, which indicates desirable maturity for shipment; the desirable pressure test on the unpeeled cheeks, however, appears to be approximately 1 pound less for Early Elberta.

PART II: EXPERIMENTS IN 1928

Procedure

Peaches of Elberta, Early Elberta, and J. H. Hale varieties were picked at 5-day intervals from August 27 to September 16 from five orchards in Boxelder, Weber, and Davis Counties. These peaches were classified and tested for maturity, stored at 50° F. from 4- to 14-day periods, removed and held in the laboratory at room temperature (65° F. to 75° F.) for 1 to 7 days until ripe, after which they were tested for condition and quality. Elberta peaches were secured from four of the same orchards used in the 1926 experiments: Beecher, Brown, Knudson, and Odell orchards. An additional orchard, the Ben Lomond Orchard, in North Ogden, was also

included in the 1928 test. The Beecher and Brown trees were "high carbohydrate" in growth status; the Knudson trees made a moderate growth and were intermediate in growth status; Odell orchard was classed as "high nitrate" in nutritional status, owing to heavy heading-back pruning. The Early Elberta fruit was gathered from young trees in the Brown orchard. The trees were vigorous 4-year-olds and decidedly "high nitrate" in growth status. The J. H. Hale peaches used were from vigorous 4-year-old trees in the Brown orchard comparable with the Early Elberta trees. For the most part the fruit was large and heavily shaded with foliage.

The harvesting technique differed from that used by Abell in 1926 in that only the ripest fruit was harvested at each picking, enough fruit for a half-bushel sample in addition to the fruit required for testing being taken. Pickings were made at 5-day intervals. This procedure provided samples much more uniform in maturity than those used in 1926, when fruit was picked at random, irrespective of maturity. Because of Abell's recommendation of the suture test as being preferable, this was the only pressure test used in the 1928 and 1929 work. The same color standards were used as in 1926. Color records were made on the flesh as well as on the unblushed cheek. The "A" lots were stored from 5 to 7 days to represent shipment to middle-western markets; the "B" lots were stored from 9 to 12 days to represent shipment to southern and eastern markets. Data reported are for the "A" lots, the data for the "B" lots being incomplete and largely a repetition of those of "A" lots.

The tests for quality and condition were made after the fruit had reached eating ripeness. Condition was measured by rating firmness, bruising, wilting, decay, and over-ripeness, the last two being rated by percentage of decayed or over-ripe specimens in the lot. Firmness was described by arbitrary terms in the following order: Hard, firm, slightly soft, soft, very soft. Bruising and wilting were described as slight, moderate, or severe. Quality was measured by rating sweetness (including acidity), bitterness, texture, and quality as a whole. Sweetness was rated in the following terms: Sour, none, slightly sweet, moderately sweet, sweet and

Table 13—Elberta: Increase in size from the Knudson, Brown and Odell orchards (1928).

Orchard	No. Picking	Average Diameter (in.)	Increase in Diameter (in.)	Percentage Increase in Diameter (%)	Percentage Increase in Volume[a] (cu. in.)
Knudson	1	2.03	0	0	0
	2	2.22	.18	8.9	30.8
	3[b]	2.29	.26	12.8	45.5
	4	2.45	.42	20.7	77.9
Brown	1	1.95	0	0	0
	2	2.10	.15	7.7	24.9
	3[b]	2.29	.34	17.4	64.0
	4	2.37	.42	21.5	79.5
Odell	1	2.35	0	0	0
	2	2.28	—.07	0	0
	3[b]	2.41	.06	2.6	5.2
	4	2.56	.21	8.9	26.0
Average	1	2.11	0	0	0
	2	2.20	.09	4.3	13.4
	3[b]	2.33	.22	10.4	26.4
	4	2.45	.34	16.1	56.5

[a]Volume increase calculated as if peaches were perfect spheres.

[b]Best picking.

very sweet. Bitterness was rated as slight, moderate, and bitter. Texture was rated as juicy, moderately juicy, or dry. General quality was described as poor, fair, good, or excellent.

Presentation of Data and Discussion of Results

Results with Elbertas

Increase in Size during Harvest. Data on increase in size of fruit from the Knudson, Brown, and Odell orchards are summarized in Table 15 and presented graphically in Figure 2. The increase in volume was calculated as if the fruits were perfect spheres. Since they are oblong and flattened and the minimum transverse diameter measurements were used in the calculation, the increase in volume (and hence in yield) was undoubtedly greater than that indicated by the figures presented.

Analysis of data on size increases indicates a strikingly large increase in size from the first to the last picking. Figured on a volume basis, the second, third, and fourth pickings in the Brown orchard showed the following percentage increases over the first picking: 24.9, 64, and 79.5 per cent, respectively. The indicated yield, as well as the size of fruit, then, would be 25 per cent more by delaying until the second picking, 64 per cent more by delaying harvesting until the third picking, and 80 per cent increase in size and yield when delayed to the fourth picking. When data from the three orchards are averaged, the percentage increases in volume over the fruit of the first picking are 13.4 per cent for the second picking, 26.4 per cent for the third picking, and 56.5 per cent for the fourth picking.

When the data for the second picking of the Brown orchard, representing a degree of maturity commonly found in fruit harvested for distant markets, are used as a base, the third picking (the best maturity stage for shipment in the 1928 experiments) gave an increase of 31.6 per cent over the size of fruit (as well as the yield) obtained by harvesting at the greener stage. Delaying harvesting to the fourth picking (a degree of maturity suitable only for local or nearby markets) gave an increase of 45.5 per cent. The increase in volume from the third picking to the fourth was 10.5 per cent. Using the averages for the three orchards, the fruit of the third picking was 11.5 per cent larger by volume than the second picking and the fourth picking was 38 per cent larger than the second. The increase in volume from the third to the fourth picking was 23.8 per cent.

Quality and Condition of Fruit from Different Pickings after Storage. The quality and condition of the fruit picked at different stages of maturity, together with presure test, skin color, and flesh color averages for each picking, are summarized in Table 14. Data given are averages for the five orchards from which Elbertas were harvested. Pickings were at 5-day intervals.

Descriptions of Experimental Lots

Harvesting indexes, together with the quality and condition of the fruit from each picking, are briefly summarized as follows:

First Picking—Fruit of the first picking, which had an average color of 1.4 (green, Plate 1) and a pressure-test average of 12.2 pounds, was far too immature, being bitter and only slightly sweet, and hence of poor quality. Such quality discourages consumption. Color after storage was 2.7 (almost sulfur yellow).

Second Picking—This fruit averaged 1.9 color (greenish yellow) and 10.5 pounds' pressure at picking. After storage it ranked fair and fair to poor in quality, being slightly to moderately sweet, slightly bitter, and moderately juicy. It proved to be hardly mature enough to develop satisfactory quality, although the fruit was of desirable firmness.

Third Picking—This was the best picking, giving the best quality of any lots and showing little or no spoilage. When harvested, these lots showed an average pressure of 8.5 pounds and a color of 3.2 (sulfur yellow). After storage these peaches were fairly firm, amber yellow to corn yellow in color, and of fair to good quality, being moderately sweet, moderately juicy to juicy, with almost no bitterness. These peaches were firm enough for usual handling and home canning but possibly not as firm as desired by wholesale trade.

Fourth Picking—Pressure had decreased to an average of 5.6 pounds in the fourth picking, while color had intensified to between amber yellow and corn yellow—4.6 on the color

Table 14—Elberta: Pressure test, skin color and flesh color at harvest in relation to condition and quality after storage (average of all orchards, 1928).

"A" Lots Only Pick-ings	MATURITY TESTS			TESTS AFTER STORAGE											
	Pressure at Harvest	Skin Color[a]	Flesh Color	Pressure after Storage	Skin Color	Flesh Color	Firmness	Bruising	Wilting	Decay	Over-ripe	Sweetness	Bitterness	Texture	Quality
1st	12.2	1.4	..	5.8	2.7	3.4	Firm	Almost none	Almost none	None	None	Very slight	Mod. bitter	Mod. juicy	Poor
2d	10.5	1.9	3.1	2.8	2.9	3.6	Firm to slightly soft	None to slight	Slight	Practically none	None	Slight to moderate	Slight	Mod. juicy	Fair
3d[b]	8.5	3.2	4.4	2.5	4.3	5.3	Slightly soft	Slight	None	None	Almost none	Moderate-ly sweet	Almost none	Mod. juicy	Fair to good
4th	5.6	4.6	5.5	Under 2	5.9	6.1	Soft	Moderate	None	3 lots none 2 lots 4% and 5%	4% to 35%	Sweet	None	Juicy	Good to excel.
5th	2.2	4.7	5.4	Under 1	5.8	6.2	Soft	Severe	None	26%	10%	Sweet	None	Juicy	Excel.

[a]See color chart, Plate 1. (Decimals indicate hues between standard colors.)

[b]"Best Picking" for distant shipment.

chart. These peaches developed good to excellent quality but were soft and had some decay and considerable over-ripes among them, indicating too advanced maturity for distant shipment.

Fifth Picking—This fruit averaged only 2.2 pounds in pressure, was highly colored—4.7 (almost corn yellow), and was eating ripe on the tree. When removed from storage it was extremely soft, badly bruised, showed heavy decay, and many over-ripes. The quality, however, was excellent.

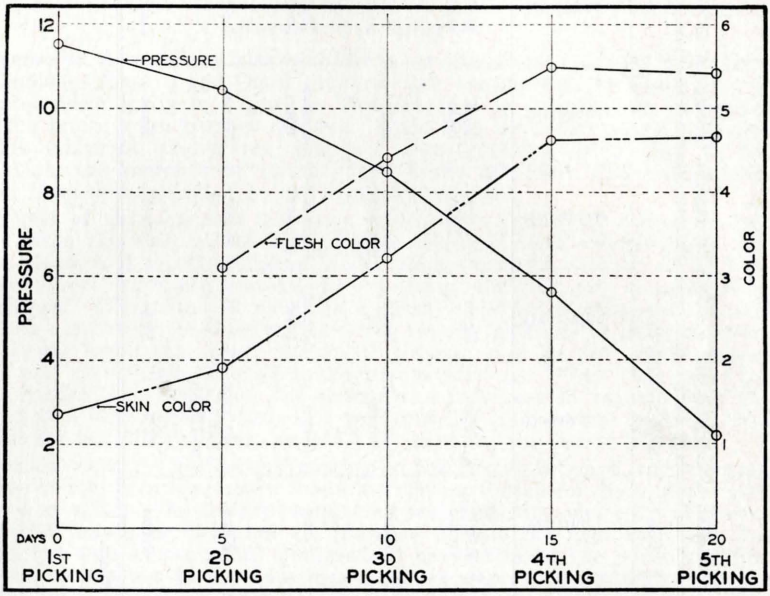


Figure 8—Pressure Tests, Skin Color, and Flesh Color of Elberta Peaches, 1928—Pressure is given in pounds for tests on peeled suture. Color numbers represent colors in color chart (Plate 1). Pickings were 5 days apart.

Pressure Tests. Average pressure tests for the different pickings of Elberta peaches in the different orchards studied are summarized in Table 15 and presented graphically in Figures 5, 6, and 8.

Table 15—Elberta: Average pressure tests on peeled suture, harvested at 5-day intervals from four Utah orchards (1928).

Picking	ORCHARD				Average All Orchards
	Knudson	Beecher	Odell	Ben Lomond	
1st	11.8	12.6	12.8	11.8	12.2
2d	9.9	10.5	11.0	10.7	10.5
3d*	8.8	8.4	8.4	8.3	8.5
4th	5.9	5.3	5.5	. . .	5.6
5th	2.2	. . .	. . .	. . .	2.2

*"Best Picking" for distant shipment.

Data presented showed the most desirable stage of maturity in 1928, as indicated by the pressure test, to be within 8 to 9.5 pounds, measured on the suture. Peaches picked at 9.5 to 11 pounds were hardly fair in quality. Picking at this stage might be justified for unusually long shipments or in large orchards where it is necessary to start somewhat early to avoid loss from over-ripeness. Fruit testing over 11 pounds was mostly of poor quality and usually bitter.

These limits of pressure differ from those of Abell, who gave 10 to 11.5 pounds as the best range, with peaches testing less than 10 pounds as too ripe. As mentioned before, Abell's samples were picked at random on selected trees and included all stages of maturity, with consequent wide variation in maturity within the samples. The more mature pickings, therefore, had a considerable proportion of peaches riper than the average, which became over-ripe and caused the entire lot to be classified as too mature for safety. In the present study, the ripest peaches on the trees were picked each time, giving more uniform samples.

The fairly uniform decrease in pressure as maturity advanced would indicate promise for this test as a measure of maturity.

Color Indexes. Color averages for each picking in each Elberta orchard studied are given in Table 16.

Table 16—Elberta: Ground color[a] from different pickings in relation to quality and condition after storage (1928).

Orchard	No. Picking	Ground Color of Skin	Flesh Color	Freedom-of-Pit Test	Quality	Percentage Decay and Over-ripes
Knudson	1	1.3	..	Mostly cling	Poor	0
	2	1.9	2.9	Mostly free	Poor to fair	0
	3[b]	3.0	4.3	Nearly free	Fair to good	3
	4	4.3	5.8	Free	Good	35
	5	4.9	5.4	Free	Excellent	45
Beecher	1	..	..	.....	Poor	0
	2	2.1	2.9	Semi-cling	Fair	0
	3[b]	3.4	4.5	Almost free	Fair to good	0
	4	5.4	6.0	Free	Good to excel.	5
Brown	1	1.7	..	Cling	Poor	0
	2	2.0	3.5	Semi-cling	Fair	0
	3[b]	3.7	5.2	Semi-cling	Good	6
	4	4.0	4.4	Free	Excellent	15
	5	4.6	5.4	Free	Excellent	29
Odell	1	1.4	..	Semi-cling	Almost fair	0
	2	1.8	4.0	Nearly free	Poor to fair	2
	3[b]	3.4	4.8	Free	Good	5
	4	4.7	5.6	Free	Excellent	4
Ben Lomond	1	1.0	..	Cling	Poor	0
	2	1.5	2.2	Semi-cling	Fair	0
	3[b]	2.5	3.4	Free	Fair to good	0
Average	1	1.4	..	Cling	Poor	0
	2	1.9	3.1	Semi-cling	Fair	0–2
	3[b]	3.2	4.4	Nearly free	Fair to good	0–6
	4	4.6	5.5	Free	Good to excel.	0–35
	5	4.7	5.4	Free	Excellent	29–45

[a]Undercolor or color on unblushed cheek (See color chart, Plate 1).

[b]Best picking for distant shipment.

Data indicate the best stage of maturity to be shown by Color No. 3 (sulfur yellow) on the color chart (Plate 1). The best pickings lay between 2.5 (between greenish yellow and sulfur yellow) and 3.7 (between sulfur yellow and amber yellow). When the latter color was reached and an orange tinge became evident, as ordinarily handled, peaches were too ripe for distant shipment.

This color range agrees with that recommended by Abell (1927). He says: "Results for 1926 indicate the desirability of picking Elberta for shipment after it has gained a distinct yellow color and before it has gained the orange color as observed on the unblushed cheek." Morris' (1927) recommendation of an orange yellow about the red color may be the same, since color is usually more intense on the red-colored cheek than on the unblushed side.

Flesh color averaged higher than skin color in the less mature stages but was nearly equalled by skin color as the peaches ripened. (Fig. 9.)

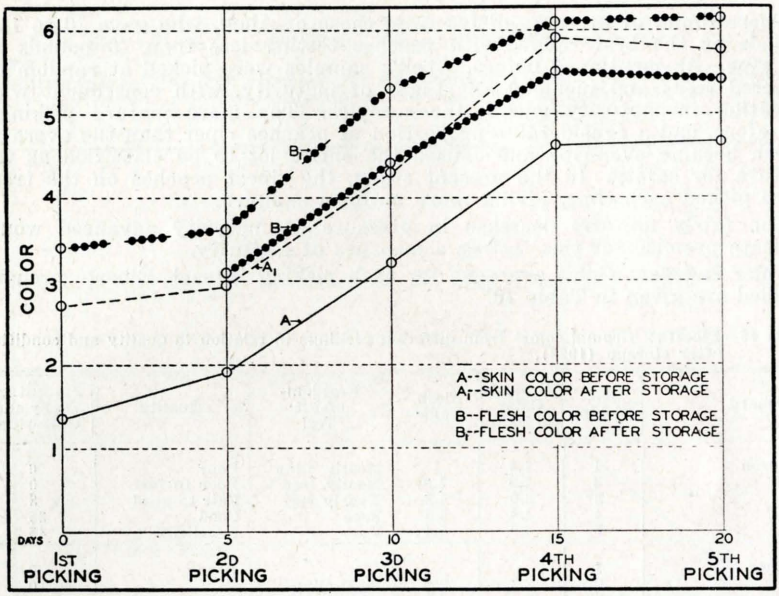


Figure 9—Skin Color and Flesh Color of Elberta Peaches before and after Storage, 1928—Skin Color: A and A_1; **Flesh Color:** B and B_1. Color numbers refer to color chart (Plate 1). Colors Nos. 1 and 2 are green, Nos. 3 and 4 yellow, and Nos. 5 and 6 orange in hue.

Freedom-of-Pit Test. Freedom-of-pit test data for Elbertas are included in Table 18. Most of the fruit of the third or best picking in the 1928 experiments was freestone or nearly freestone at time of harvest, although some lots had a considerable portion of semi-clingstone fruit. While this test may be helpful in connection with color and pressure tests, from data obtained, however, it is apparently not reliable alone because of variation between the different orchards. Delaying harvest until all fruit showed freestone pits would have resulted in much soft and over-ripe fruit in several orchards. Freedom-of-pit tests made after storage showed little change in the freedom of the pit during storage and ripening.

Results with Early Elberta

Maturity tests on the different pickings, together with quality and condition data for the fruit from the Brown orchard, are given in Table 17. Pressure tests and both skin and flesh color changes for Early Elbertas are shown in Figure 10.

The "Best Picking" stage of Early Elbertas in the Brown orchard lay between the second and the third pickings. The first picking, with a skin color of 1.7 (greenish yellow), when removed from storage, was firm to slightly soft, clingstone, poor to fair in quality, with no decay or over-ripe fruit. The second picking (with 10.5 pounds' pressure test and 2.7 color —almost sulfur yellow) was slightly soft, fair in quality, and had no decay or "over-ripes." The third picking, which tested 7 pounds' pressure and 3.4 in color (between sulfur yellow and amber yellow), was good in quality, had no decay or over-ripe fruit, but was slightly soft to soft. Because of the undesirable softness of the third picking, the ideal picking maturity lay between the second and third pickings, probably at about 8.5 to 9 pounds' pressure and Color No. 3 (sulfur yellow). The fourth picking (with 4.8 pounds' pressure and 4.8 color—nearly corn yellow) was good to excellent in quality, being sweet and juicy and showing no decay; however,

Table 17—Early Elberta: Color and pressure tests at harvest in relation to quality and condition after storage (Brown orchard, 1928).

No. Picking	Maturity Tests at Harvest			TESTS AFTER STORAGE											
				CONDITION								QUALITY			
	Pressure	Skin Color	Flesh Color	Pressure	Skin Color	Flesh Color	Firmness	Bruising	Wilting	Decay (%)	Over-ripe (%)	Sweetness	Bitterness	Texture	Quality
1st	..	1.7	..	2.9	3.6	4.4	Firm to slightly soft	Slight	Almost none	0	0	Slight	Slight	Moderately juicy to juicy	Poor to fair
2d	10.5	2.7	4.3	2.3	4.0	5.2	Slightly soft	Slight	Few slight	0	0	Slight to moderate	Few slight	Moderately juicy	Fair
3d	7.0	3.4	5.2	2.0	5.6	6.0	Slightly soft to soft	Slight to moderate	None	0	0	Moderate	None	Moderately juicy to juicy	Good
4th	4.8	4.8	6.0	1.0	6.0	6.8	Soft to very soft	Moderate	None	0	49	Sweet	None	Moderately juicy to juicy	Good to excellent
5th	3.4	5.5	6.0	0.5	6.0	5.3	Very soft	Severe	None	53	20	Moderate	None	Moderately juicy to dry	Fair

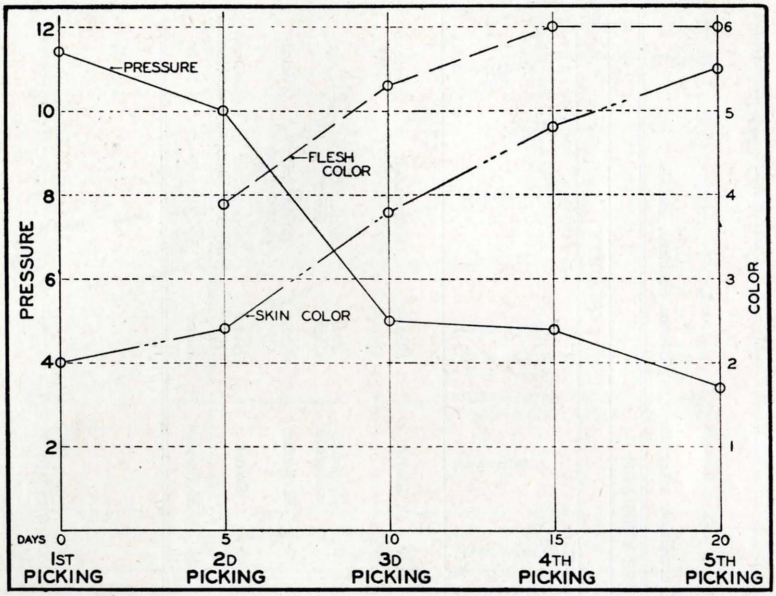


Figure 10—Pressure Tests, Skin Color, and Flesh Color of Early Elberta Peaches, 1928—Pressure is given in pounds for tests on peeled suture. Color numbers refer to colors in color chart (Plate 1).

it was soft to very soft and had 49 per cent over-ripe fruit. The fifth picking (showed 3.4 pounds' pressure and 5.5 color—between corn yellow and Mirabelle) was extremely soft, severely bruised, only fair in quality, and showed 53 per cent decay and 20 per cent over-ripe fruit. It should be borne in mind that this fruit was from highly vigorous young trees with "high-nitrate" growth status. Fruit from "high-carbohydrate" trees at the same stage of maturity would probably have shown higher color and better carrying quality.

Results with J. H. Hale Peaches

Maturity data and quality and condition after storage of J. H. Hale peaches from the Brown orchard are tabulated in Table 18 and are shown graphically in Figure 11. The first picking was stored for eight days, the second, third, and fourth each for five days, and the fifth picking for seven days.

The first picking of J. H. Hales (testing 10.9 pounds' pressure when picked and 1.5 color—between green and greenish yellow) was firm with no decay or over-ripeness; it was poor to fair in quality. The second picking tested 11.1 pounds' pressure, represented Color No. 2 (greenish yellow); after storage it was firm with no decay or "over-ripes" and only fair in quality. The third picking, testing 9.1 pounds and representing 3.1 color (sulfur yellow), was firm to slightly soft, and no decay or "over-ripes," and was fair to good in quality. While not as good quality as the fourth or fifth pickings, the third picking was the best quality picking which was firm enough to stand handling when removed from storage. The fourth picking tested 5.7 pounds and represented Color No. 4 (amber yellow). The fruit from this picking was good in quality and showed no decay; it was soft, however, and contained 11 per cent over-ripe fruits. The fifth picking, testing 3.6 pounds and representing 3.7 color, was somewhat firmer than the fourth and showed no decay or "over-ripes" when removed from storage. This lot was probably made up of later maturing fruits from heavily-shaded lower branches.

Table 18—J. H. Hale: Pressure test and color at harvest in relation to condition and quality after storage (Brown orchard, 1928).

Picking	Maturity Tests at Harvest			Tests after Storage			Condition after Storage					Quality			
	Pressure	Skin Color	Flesh Color	Pressure	Skin Color	Flesh Color	Firmness	Bruising	Wilting	% Decay	% Over-ripeness	Sweetness	Bitterness	Texture	Quality
1st	10.9	1.5	..	4.3	3.0	3.9	Firm	Half sl. bruised	None	0	0	Slight	Slight	Juicy to Mod.	Poor to Fair
2d	11.1	2.0	3.1	2.9	3.1	4.1	Firm	Slight	Slight	0	0	Slight to Mod.	Slight	Mod. juicy	Fair
3d*	9.1	3.1	4.3	2.6	3.9	4.5	Firm to Sl. soft	None	None	0	0	Slight to Mod.	Sl. to None	Juicy	Fair to Good
4th	5.7	4.0	5.4	Under 1 lb.	5.2	5.8	Soft	Mod.	None	0	11	Sweet	None	Juicy	Good
5th	3.6	3.7	4.8	Under 2 lbs.	4.6	5.4	Sl. soft	Mod.	None	0	0	Mod.	None	Juicy to Mod. juicy	Good

*"Best Picking" for distant shipment.

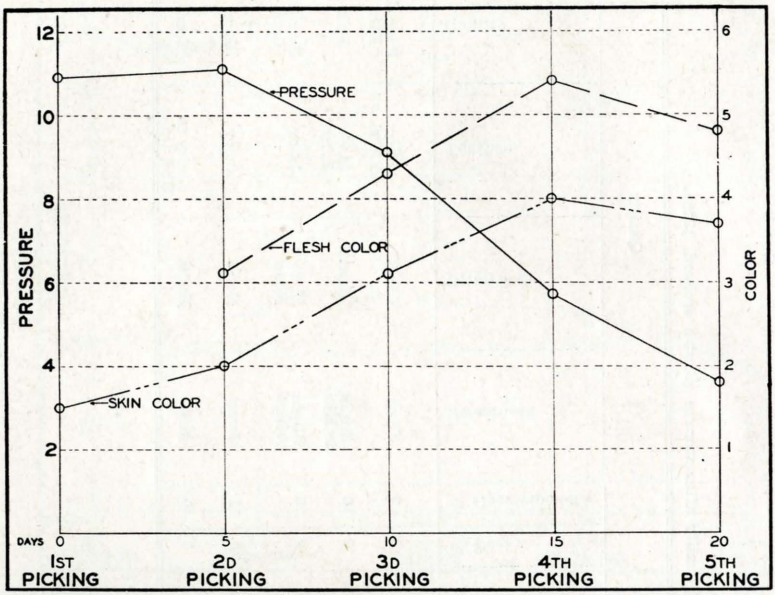


Figure 11—Pressure Tests, Skin Color, and Flesh Color of J. H. Hale Peaches, 1928—Pressure is given in pounds for tests on peeled suture. Color numbers refer to colors in color chart (Plate 1).

Results from this experiment indicate that the same pressure test and color range which represented the best stage of maturity for the Elberta in the 1928 experiments (8 to 9.5 pounds' pressure and Color No. 3—sulfur yellow) indicated the best picking maturity for J. H. Hale peaches of the "high-nitrate" type. It appears probable that "high-carbohydrate" J. H. Hale peaches would show higher color and better carrying quality for the same pressure test and could be picked somewhat riper, with satisfactory results, than could Elberta peaches. Practical experience and later experiments support this possibility.

Conclusions from the 1928 Experiments

(1) Pressure test and color together appear to be the best indexes to picking maturity in Elberta type peaches.

(2) Elberta peaches stored at 50°F. for five days and held from two to four days at 70°F. (conditions similar to transportation under refrigeration and handling in middle-western markets) developed best quality with least loss when picked at a pressure of from 8 to 9.5 pounds (suture test) and colors corresponding to from 2.5 to 3.5 (sulfur yellow, Plate 1) under the conditions of this experiment.

(3) Picking peaches at a less mature stage (over 9.5 pounds and from green to greenish yellow in color) resulted in lower yield, smaller size, and poor quality.

(4) Peaches picked at a riper stage (less than 8 pounds' pressure and color from amber yellow to Mirabelle—Colors Nos. 4 to 6, Plate 1) developed still better quality and larger yields; however, they were soft and "wasty" when removed from storage similar to commercial refrigeration and handling to distant markets. Peaches of this maturity should be used only for nearby and local markets.

(5) Flesh color likewise increases with ripening. The flesh is more highly colored than the skin in the greener stages but is equalled by the skin color when the peach is quite ripe. This test seems to offer no advantages over the skin-color test.

(6) Freedom of stone does not seem to be uniformly proportional to maturity under all conditions. Little change in degree of clinging appears to accompany ripening off the tree..

(7) Early Elberta and J. H. Hale varieties showed practically the same optimum range of pressure and color for picking as did the Elberta, although the former softened at a faster rate.

PART III: PEACH-MATURITY EXPERIMENTS, 1929

Procedure

Unusual Weather Conditions Precede 1929 Harvest. The 1929 peach harvesting season was two weeks later than usual and was preceded by an unusually prolonged spell of cold, rainy weather. Probably because of this, many peaches did not develop normal color and to a large extent softened while green. Because of lack of normal color, in many cases harvest was delayed, resulting in over-ripe peaches on the market and heavy losses both to shippers and to growers. This experience corroborated the observations of previous workers: **Peaches may not develop normal color, quality, or carrying quality during cold, wet seasons.**

Orchards and Harvesting Methods Used. In the 1926 and 1928 experiments, fruits of different stages of maturity (harvested at the same picking) were stored together in the same lot, following the taking of records as to color and pressure test. As a result, averages of quality, firmness, color, etc. in many cases covered rather too wide a range of conditions of the individual fruits to be accurate. In order to remedy this source of error and to reduce the cost of the experiments, in 1929 it was decided to confine the tests to a single orchard of each variety, using several trees to secure a large enough quantity of fruit to permit classifying by color, as well as by size and picking. It was hoped to obtain uniform samples which would show more accurately which color and pressure test of each variety gave the best quality and condition with the least spoilage.

Elberta peaches were taken from the same block of trees owned by Mr. Ben Knudson of Brigham City which furnished fruit for the 1926 and 1928 experiments. These trees were semi-cultivated, heavily pruned, rather vigorous vegetatively, carried a moderate crop, and were "high nitrate" in growth status. The J. H. Hale peaches were taken from another orchard of Mr. Knudson's. These trees were only moderately vigorous and carried a light-to-moderate crop of large fruit. They were fairly well cultivated. They were classified as to growth status as intermediate or "high carbohydrate." The Early Elberta fruit was taken from vigorous 7-year-old trees at the bottom of Mr. Nello Christofferson's orchard at Brigham City.

While it was planned to make three pickings of each variety, the second picking was evidently too ripe and no third picking was made. Only one picking was made with the Early Elberta for the same reason. At each picking, approximately one-half of each tree was picked, thus getting the full range of ripeness which existed in the fruit on the tree at that time. Pickings of J. H. Hale were made on September 11 and September 18; Early Elbertas were picked on September 11; and Elbertas were picked on September 15 and September 22.

To study growth during the harvest season more accurately than was possible by measuring the fruits removed at each picking as done in 1926 and 1928, one hundred each of Elberta and J. H. Hale fruits were tagged and numbered in advance of the harvest season to be measured every five days. Only two measurements were made—on September 8 and 13. On the 18th so many fruits had dropped that a third measurement was not made.

In order to imitate temperature conditions in an iced refrigerator car, which often requires 72 hours to bring a load of peaches to refrigeration temperature, storage of the fruit was delayed for approximately 72 hours at from 60° to 65° F. before placing in cold storage. Fruit of the first picking of all three varieties and the second picking of the J. H. Hales was stored on the campus in a cold-storage room of the Department of Dairy Manufacturing. The temperature of this room was maintained within a few degrees of 50° F., the usual temperature of the top layer of fruit in a refrigerator car. It was felt that the maximum temperature found in loaded refrigerator cars should be used rather than the minimum, since over-ripeness and decay are more serious in marketing than is greenness. Because of lack of storage space, the second picking of Elbertas was stored in a fruit cellar at from 55° to 60° F.

The fruit was tested and classified the day following picking, the final tests being made within 24 hours after picking. This delay in testing gave somewhat lower (possibly a pound less) values than testing immediately after removal from the tree.

In classifying the first picking, it became evident that the original plan of sorting according to color alone would result in putting hard and soft fruit together, since a considerable portion of the fruit was much softer to the touch, considering color, than was normal fruit. To obtain uniform maturity lots, such fruit was placed with a lot of higher color having about the same firmness. Thus, in the first picking, both color and firmness to touch were used in classifying the fruit. In the second picking, while the same color lots were used firmness was the determining factor in sorting the fruit into lots. With this method, the majority of fruit in a lot corresponded to the color indicated by the lot number; however, the lot also contained fruit of a lower color with the same degree of firmness. In sorting for firmness and in rating this factor after storage, the following arbitrary ratings were used: No. 1—hard or very hard; No. 2—fairly hard; No. 3—rubbery to firm; No. 4—firm to fairly firm; No. 5—slightly soft; No. 6—soft; No. 7—very soft. Before sorting by color and firmness, peaches were sorted into quarter-inch sizes to determine if different maturity indexes were required for different sizes of fruit. For Elbertas and Early Elbertas sizes were 1¾ to 2 inches, 2 to 2¼ inches, and over 2¼ inches; for J. H. Hale 2¼ to 2½, 2½ to 2¾, and over 2¾ inches. While the aim was to have a bushel of fruit of each size and color, most lots were smaller than this. In most cases, 10 fruits of each size and color lot were tested for pressure. With from 2- to 4-size lots in each maturity lot, each pressure-test average represents individual tests on 20 to 40 fruits.

Following harvest, 10 to 20 fruits of each lot were rated carefully as to firmness, freedom of pit, skin and flesh color, sweetness, bitterness, texture or juiciness of flesh, flavor, and quality, rating each fruit for each character according to an arbitrary scale. Data on the lots given in the tables represent averages of tests and ratings for individual fruits. Color No. 7, noted in some cases, is a reddish orange hue somewhat deeper than Color No. 6 (Mirabelle, Plate 1).

PRESENTATION AND DISCUSSION OF RESULTS

Increase in Size during Harvest

Increase in size for Elbertas and J. H. Hales between September 8 and September 13 (five days immediately preceding the first picking, which proved to be the proper maturity for shipment for most of the fruit) is presented in Table 19.

In the five days preceding harvest, Elberta peaches grew from an average diameter of 2.08 to 2.26 inches, an increase of 8.6 per cent in diameter, or 29.6 per cent in volume, figured as a sphere. In the same period J. H.

Table 19—Elberta and J. H. Hale: Increase in size during five days preceding harvest (Knudson orchard, 1929): Average of 100 fruits.

MEASUREMENT	DATE OF MEASUREMENT		Percentage Increase
	September 8	September 13	
Elberta			
Average diameter (in.)	2.08	2.26	8.6
Average volume (cu. in.)	4.71	6.04	29.6
J. H. Hale			
Average diameter (in.)	2.70	2.89	7.0
Average volume (cu. in.)*	10.33	12.67	22.4

*Calculated as a sphere.

Hale peaches increased in diameter from 2.7 to 2.9 inches, an increase of 7 per cent in diameter, or 22.4 per cent in volume.

Results with Elberta Peaches

Results for both first and second pickings of Elberta are tabulated in Table 20, the different sizes in each lot being averaged together.

Table 20—Harvesting indexes in relation to quality and condition of Elberta peaches (Knudson orchard, 1929).

Lot No.[a]	First Picking (Sept. 15) (Stored 16 days at 35-45° F.)			Second Picking (Sept. 20) (Stored 12 days at 55-60° F.)		
	2	3	4	2	3	4
Tests at Harvest						
Firmness	Fairly hard	Rubbery to firm	Firm to fairly firm	Fairly hard	Rubbery to firm	Firm to fairly firm
Pressure Test[b] Suture (lbs.)	6.4	4.3	3.8	3.6	1.9	1.3
Pressure Test[b] Cheeks (lbs.)	10.3	6.8	5.2	6.3	3.6	1.9
Skin Color	Under 2.5	2.5-3.5	3.5-4.5	Under 2.5	2.5-3.5	3.5-4.5
Tests after Storage						
Firmness	Firm to slightly soft	Mostly slightly soft	Slightly soft to soft	Fairly firm to soft, mostly slightly soft	Slightly soft to soft	Soft and very soft
Skin Color	3	4	5	3-4	5	Mostly 5
Quality	Fair	Fair to good	Good	Fair—lacks sweetness	Good	Good
Decay	0	0	0	0	14%	15%
Over-ripes	0	0	0	0	3%	20%

[a]In the first picking peaches were sorted by color and firmness to correspond to the color chart. Peaches markedly softer than the rest of their color were put in a higher color lot. The second picking was sorted according to firmness only, the lot numbers corresponding to those used in the first picking.

[b]Both tests made on peeled surface of fruit. "Cheek" test is average of both cheeks. Pressure tests were made 18 to 24 hours after picking, hence are somewhat lower than those made immediately after picking.

Description of Experimental Lots

First Picking. All lots of the first picking, although stored in a room with a temperature of 50° F., were stored above the brine tank which proved to be a colder location, the temperatures ranging from below 32° F. nearest the tank to 45° F. in the top box of fruit. Quality and condition data were taken from fruit on top.

Lot 2 (based on Color No. 2 when picked and testing 6.4 on the suture test) ranged from greenish yellow to amber yellow in color (Nos. 2 to 4, Plate 1), with sulfur yellow (Color No. 3) predominating. After storage, firmness varied from firm to slightly soft, most of the lot being fairly firm to slightly soft. This lot was unattractive in appearance but was firm enough to stand considerable handling and holding. Quality was poor to fairly good, although fair predominated.

After storage Color lot No. 3 (sulfur yellow and testing 4.3 pounds' pressure, suture test, before storage) varied from sulfur yellow to corn yellow (Colors 3, 4, and 5), with amber yellow predominating. The fruit was mostly slightly soft. On the whole, this lot presented an attractive appearance and apparently was in condition to stand a fair amount of handling and holding. The condition of this lot should be especially acceptable to the wholesale receiver. Quality was much better than in Lot 2, being fair to good.

Lot 4 (amber yellow and testing 3.8 pounds on the suture before storage) was slightly soft to soft after storage and ranged from sulfur yellow to Mirabelle (Colors Nos. 3, 4, and 5), with amber yellow and corn yellow predominating. The fruit in this lot presented an attrac-

tive appearance, showing considerable red; however, in large measure it was too soft for handling and was suitable only for immediate use. If it were not for the low temperatures above the brine tank, Lot 4 would probably have shown considerable "over-ripes" and spoilage. None of the first picking lots contained spoiled or over-ripe specimens.

Second Picking. Because of lack of storage space in the refrigerating room, all Elbertas of the second picking were stored in the fruit cellar at a temperature of from 55° to 58° F. The general or prevailing condition after 12 days' storage was over-ripe, with considerable decay.

After storage, Lot 2 (greenish yellow and testing 3.6 pounds before storage) was fairly firm to soft, most of the fruit being slightly soft. The color of fruit in this lot was sulfur yellow to amber yellow (Colors Nos. 3 and 4). Quality was fair, but both sweetness and bitterness were lacking. This lot was entirely free from decay or over-ripe fruit.

Lot 3 (sulfur yellow and testing 1.7 pounds on the suture when stored) was slightly soft to soft, with corn yellow predominating. The quality was good; however, the 17 per cent decay and "over-ripes" and the softness indicated was too advanced maturity for safe shipment.

Lot 4 (amber yellow and testing 1.1 pounds before storage) was soft and very soft after storage, mostly corn yellow and Mirabelle in color, and was good in quality; however, Lot 4 had a high percentage of "over-ripes" and decay, totaling 35 per cent.

Discussion

In the Elberta experiment of this year (1929) when color development was not normal, the first picking proved to be the "Best Picking." The original plan had been to provide from this picking peaches which were too immature for shipment. The second picking, with the exception of the firmest and greenest lot of fruit, proved to be too ripe for safe distant shipment. Even the ripest lot of the first picking when removed from storage was somewhat too soft for satisfactory handling. Pressure-test readings for fruit which appeared to be of equal maturity with that used in the 1928 tests were extremely low, averaging 2 or 3 pounds less than in the 1928 tests. This difference may have been due partly to the delay in testing after picking. Allowing 2 pounds for this delay, however, a pressure of 6.3 pounds is indicated, which is lower than that indicated for both 1926 and 1928.

The suture test on the peeled cheek immediately beside the suture, as recommended by Abell (1927), was not satisfactory because of the low range of readings obtained with this test. The flesh in a limited area at this point is usually much riper, softer, and better-colored than that of the rest of the peach. This area is so limited, however, that the softness of the flesh at that point is not the limiting factor which determines shipping and handling qualities. This is not true of the flesh under the broad cheeks which are exposed to many more bruising contacts. In the 1929 tests, pressure tests made on the peeled cheeks averaged 2 to 4 pounds higher than those made on the suture. The poor color and low-pressure tests may also have been partially due to the nutritional status of the trees, which were not far from being "high nitrate" in classification.

Results with Early Elberta Peaches

The 1929 results for Early Elbertas are tabulated in Table 21.

Description of Experimental Lots

Lot 2 (which was greenish yellow and before storage tested 10.4 pounds on the suture) was slightly soft to soft and sulfur yellow to amber yellow when removed from storage. The quality was good.

Lot 3 (sulphur yellow and testing 8.6 pounds before storage) represented the ideal condition for arrival on eastern markets. Color was mostly sulfur yellow to amber yellow, with about a third of the fruits showing corn yellow. Most of the fruit was fairly firm to slightly soft—sufficiently firm to stand necessary handling. There was little red color, particularly in the larger sizes. The quality was mostly good.

Lot 4 (amber yellow in color and testing 5.5 pounds before storage) was most attractive, being amber yellow to corn yellow in color, somewhat softer than dealers usually desire but firm enough to stand some handling. There were no decayed peaches and no "over-ripes."

As would be expected, Lot 5 (corresponding to Color No. 5—corn yellow—and testing 3.6 pounds before storage) was nearly all soft and very soft when removed from storage, high

in color with corn yellow predominating, and with more red color than was evident in the other lots. Quality was mostly good to excellent, with 7 per cent decay and "over-ripes." This lot was evidently too ripe for shipment.

Table 21—Early Elberta: Harvesting indexes in relation to quality and condition (Christofferson orchard, 1929) (Delayed 2½ days at 63°F.; stored 6 days at 50°F.)

Lot No.[a]	COLOR NO.			
	2	3	4	5
Tests at Harvest				
Firmness	Fairly hard	Rubbery to firm	Firm to fairly firm	Slightly soft
Pressure Test[b] Suture (lbs.)	10.4	8.6	5.5	3.6
Pressure Test[b] Cheeks (lbs.)	11.7	11.5	8.7	5.2
Skin Color	Under 2.5 (Greenish yellow)	2.5-3.5 (Sulfur yellow)	3.5-4.5 (Amber yellow)	4.5-5.5 (Corn yellow)
Tests after Storage				
Firmness	Slightly soft to soft, mostly soft	Fairly firm to soft, mostly slightly soft	Slightly soft to soft	Nearly all soft
Pressure	Under 1	Under 1	Under 1	Under 1
Skin Color	4.3	4.8	5.0	5.9
Flesh Color	5.3	5.2	4.7	4.9
Quality	Good	Fair to good, mostly good	Fair to good	Fair to excellent mostly good
Decay	0	0	0	2%
Over-ripe	6%	0	0	5%

[a]Peaches were sorted by color and firmness to correspond with the color chart. Fruits markedly softer than the rest of their color were put with those of a higher color.

[b]Both pressure tests made on peeled surface of fruit. "Cheek" test is average of tests on both cheeks.

Discussion

Keeping in mind the wholesale dealers' preference for firm peaches, Lots 2 and 3 (especially the latter) were most suitable for distant shipment. This would indicate a pressure range for Early Elberta of the "high-nitrate" type of from 8.5 to 10 or 10.5 pounds' pressure test on the suture. This is about the same range, with the exception of being somewhat higher, than that indicated by the 1928 data. The optimum color indicated by both experiments is the same—sulfur yellow (Color No. 3), with peaches slightly greener in hue being safer for distant shipment, as ordinarily handled, than those of deeper hue.

Description of Experimental Lots

First Picking—Lot 2 (greenish yellow and testing 8.2 pounds on the suture before storage) was unattractive in appearance when removed from storage, firm enough to stand handling, but only fair in quality. Many of the peaches were much softer than their color indicated.

Lot 3 (sulfur yellow and 5.8 pounds' pressure before storage) in the main appeared to satisfy the demands of the trade for fruit firm enough to stand handling. Firmness varied from firm to soft, most of the fruit being fairly firm to slightly soft. Some fruit, however, was soft in spite of lack of color. Color ranged from greenish yellow to corn yellow, averaging sulfur yellow (Color No. 3), with amber yellow predominating. The quality was mostly fair to good. This lot was not as attractive as the riper lots, having less red color.

Lot 4 (with amber yellow average color and testing 5.7 pounds on the suture before storage) appeared to be about the maximum ripeness desired by carlot receivers when removed from storage. Firmness varied from fairly firm to slightly soft, with a few soft peaches. Color ranged from sulfur yellow to corn yellow, with amber yellow and corn yellow predominating. In spite of the high color the peaches were quite firm. Fruit showed a fair amount of red color, about one-third grading fancy in this respect. Fruit of this maturity was especially attractive and would appeal to the consumer. The quality was mostly good; there was no decay and no "over-ripes."

Lot 5 (corn yellow and testing 4.3 pounds on the suture before storage) was too ripe for handling and suitable only for immediate use when removed from storage. The color was amber yellow to Mirabelle, with sufficient red color to grade fancy. In spite of advanced maturity, none of the fruit was over-ripe or decayed; the quality was good.

Second Picking—All fruit of the second picking (made on September 18, seven days after the first) was too mature for distant shipping, as indicated by its condition upon removal from 12 days' storage. All lots, even those which were only sulfur yellow in color, were soft to very soft after storage and suitable only for immediate consumption. The fruit was more highly colored than when harvested, having advanced from one to two stages on the color chart (Plate 1). The quality was superior in the better-colored, riper lots; the amount of spoilage and over-ripeness was likewise higher.

Results with J. H. Hale Peaches

Maturity indexes and data on quality and condition after storage are summarized in Table 22.

Table 22—J. H. Hale: Harvesting indexes and quality and condition data (Knudson orchard, 1929).

Lot No.[a]	FIRST PICKING				SECOND PICKING			
	2	3	4	5	3	4	5	6
Tests at Harvest								
Firmness	Fairly hard	Rubbery to firm	Firm to fairly firm	Slightly soft	Rubbery to firm	Firm to fairly firm	Slightly soft	Soft
Pressure Test[b]								
Suture (lbs.)	8.2	5.8	5.7	4.3	4.1	3.6	2.5	Under
Cheeks (lbs.)	10.5	9.5	9.0	6.3	6.2	5.2	3.3	1
Skin Color	Under 2.5	2.5-3.5	3.5-4.5	4.5-5.5	3	3-4	3-5	3-6
Tests after Storage								
Firmness	Slightly soft	Slightly soft to soft	Slightly soft to soft	Slightly soft to soft	Soft to very soft	Soft to very soft	Soft to very soft	Soft to very soft
Skin Color	4.2	4.7	5.3	5.8	5.9	6.9	7.0	6.9
Flesh Color	6.7	6.6	5.5	6.0	6.0	7.0	7.0	7.0
Sweetness	Moderately sweet to sweet	Mostly sweet	Mostly sweet	Moderately sweet to sweet	Moderately sweet to sweet	Sweet	Mostly sweet to very sweet	Mostly sweet
Bitterness	Slight	Slight	Trace	Trace	Almost none	Trace	Trace in about a third	Trace in about a third
Texture	Moderately juicy	Mod. juicy to juicy	Mostly juicy	Juicy	Juicy	Juicy	Mod. juicy to juicy	Mod. juicy to juicy
Quality	Fair	Mostly fair to good	Mostly good	Good	Mostly good	Fair to excellent, mostly good	Good to excellent	Mostly excellent
Decay	0	0	0	0	0	0	0	7%
Over-ripe	0	0	0	0	11%	0	5%	14%

[a] In the first picking peaches were sorted by color and firmness to correspond to the color chart. Peaches markedly softer than the rest of their color were put in a higher color. The second picking was sorted according to firmness only, the lot numbers corresponding to those used in the first picking.

[b] Both pressure tests made on peeled surfaces of fruit. "Cheek" test is average of tests on both cheeks. Tests made 18 to 24 hours after picking, resulting in somewhat lower figures than where tests were made immediately after picking.

Discussion

Since Lots 3 and 4 of the first picking appeared to represent the optimum stages of maturity for shipment, as indicated by their condition and quality when removed from a storage test imitating conditions encountered in refrigerated transportation to distant markets, their maturity tests should indicate the range of color and pressure which was best for this variety under the conditions prevailing in 1929. When picked, fruit of these lots graded Colors Nos. 3 and 4 (sulfur yellow and amber yellow) and tested 5.7 to 5.8 pounds on the suture. These figures should be raised 1 or 2 pounds to allow for the delay in testing, giving about 8 pounds' pressure. This is a somewhat more advanced color and a slightly lower pressure than that suggested by the 1928 experiments, when the requirements for this variety appeared to be similar to those of Elbertas. Much of the fruit in this year's test, however, was "high carbohydrate" in type, while the fruit used in 1928 was nearly all "high nitrate," coming from especially vigorous 4-year-old trees. This lower pressure test, indicated for the J. H. Hales in 1929 as compared with 1928, is similar to results for Elbertas, fruit of much lower pressure test being more satisfactory than in previous years.

Conclusions for the 1929 Experiments

(1) From 1929 results it appears that in years of cold, rainy weather preceding harvest, color indexes alone cannot be relied upon. While pressure tests were more accurate as indexes of maturity, maturity standards set in 1926 and 1928 did not hold entirely true in 1929, when lots below the pressure tests considered a safe minimum held up satisfactorily.

(2) The pressure test would seem most useful in determining when to start picking as well as in checking on maturity of green-colored peaches. As soon as the sulfur yellow color is reached with Elbertas or Early Elbertas or the amber yellow color with J. H. Hales, it is apparently advisable to pick the peaches regardless of pressure.

(3) After the first picking, in which all the well-colored fruit would be harvested, it would seem advisable to pick all peaches regardless of color, as ripening under the conditions found this season often seems to take place without the normal color changes. Especially does this appear to be true in those peaches which mature later on the trees.

(4) It appears likely that J. H. Hale peaches can be safely shipped with a somewhat lower pressure test than can Elbertas and Early Elbertas, since lots testing as low as 5.7 pounds on the peeled cheek beside the suture were in satisfactory condition when removed from storage.

(5) No consistent differences in firmness, pressure tests, or storage quality were apparent between different sized peaches of the same color and firmness before storage.

(6) No consistent correlation was apparent between freedom of pit and color of the fruit of the same picking. Fruit of the second picking, however, had fewer clingstone fruits than that of the first picking.

PART IV: PEACH-MATURITY EXPERIMENTS, 1932

Relation to Other Experimental Work. Experiments in peach maturity carried on in 1932 were made as a necessary part of two other experimental projects: (1) Peach Pruning Experiments on the Boxelder Experimental Farm (Project 119)[6] and (2) Variety Testing of Stone Fruits at the Davis Experimental Farm at Farmington (Project 95)[7]. It was considered desirable to test the effect of the different pruning treatments employed in the pruning experiment at Brigham on the harvesting indexes (particularly ground color and pressure) and on the carrying and keeping quality of the fruit. Data on the maturity indexes of the three commercial shipping varieties—Elberta, Early Elberta, and J. H. Hale—compared in the 1928 variety test plantings at Farmington were also desired.

In view of the work of Blake and associates in New Jersey (1931) pointing out differences in the development of maturity indexes (particularly ground color) in Elberta peach trees of "high-nitrate" and "high-carbohydrate" growth status, it became especially desirable to study the effects of different pruning methods on the development of maturity indexes under Utah conditions. It was hoped that the maturity tests outlined in connection with the pruning work (1) would shed some light on the variations

[6]Initiated in 1931.
[7]Initiated in 1928.

encountered in previous maturity work as well as the effect of different degrees and types of pruning on maturity indexes and (2) would make possible harvesting recommendations for each type of "growth status" and pruning. The Farmington planting, consisting of two rows of each of the three varieties growing side by side in the second year of bearing, offered an opportunity to test fruit from these three major varieties from trees of the same age, vigor, pruning, and orchard conditions, an opportunity not available in previous work.

While these tests were made in connection with other projects, it was thought desirable to include maturity results in this publication with data from previous years. Data on pruning experiments on the Boxelder Experimental Farm and on variety-test planting on the Davis Experimental Farm are here presented.

A. EXPERIMENTS ON BOXELDER EXPERIMENTAL FARM[8]

Procedure

The trees from which the experimental fruit was taken were nine years old and of good vigor. The block, growing on stony loam, had been heavily manured the previous winter and spring and was well cultivated; it was irrigated weekly or bi-weekly during the summer and fall seasons. Fruit was taken from the following pruning treatments:

(1) **Long-pruned**—These trees were thinned out in the dormant season with no heading-back. Fruit from these trees had ample sunlight and high color. The trees were considered intermediate in growth status.

(2) **Headed-back**—These trees were severely headed-back in the spring, with no thinning. As a result, vigorous shoot growth was made; most of the fruit was heavily shaded. These trees were considered as "high nitrate" in growth status.

(3) **Unpruned Checks**—As a result of lighter foliage and lower vegetative vigor, resulting from lack of pruning, this fruit was smaller and more highly colored. These trees were considered to be "high carbohydrate" and "low nitrate" in growth status.

Three pickings were made five days apart (on September 10, 14, and 18), one-third of the peaches being picked each time without regard to ripeness. On account of the advanced maturity of the third picking, storage tests were made only on the first two pickings. Peaches were graded into quarter-inch sizes and then classified further into color lots (Plate 1). This classification was based entirely on ground color (undercolor), although it was recognized that considerable variation occurred in the firmness of the fruits placed in each lot. Pressure tests were made on ten fruits from each lot, six tests (including tests on each cheek) being made on each peach as follows: Each cheek, skin on; each cheek, skin off; suture, skin on; suture, skin off. The $\frac{5}{16}$-inch plunger was used in all tests. These tests are summarized in Table 23. Pressure tests on the first picking were made on the same day, while color sorting and pressure tests on the second picking were made on the day following picking.

Immediately after pressure tests were made, three peaches from each lot were preserved in alcohol for chemical analysis of sugar, total carbohydrate, and nitrogen. Methods and results of analyses are under "Chemical Analyses." Peaches selected represented highest pressure, average pressure, and lowest testing peach in each lot. The fruit was stored at 50° F. Both pickings were removed from storage on October 7, making a storage period of 27 days for the first picking and 23 days for the second picking, with one day's delay at the packing shed. With the shorter period required for transportation to market (from four to ten days), the fruit would have arrived in much firmer condition than was noted after the longer storage period used.

Results

Increase in Size during Harvest. Beginning August 25, 100 fruits on representative trees of each pruning treatment were measured weekly, none of the fruit being picked until after the last measurement on September 22. Averages for all treatments are given in Table 24.

[8]Near Brigham City.

Table 23—Elberta: Pressure tests from different pruning treatments: Peach pruning experiment (Boxelder Experimental Farm, Brigham, 1932).

Treatment and Harvesting Data				Pressure Tests (lbs.)			
				Cheeks		Suture	
Pruning Treatment	Picking	Size (in.)	Color No.	Skin On	Skin Off	Skin On	Skin Off
Long-pruned	1	2	2	21.5	14.5	16.5	11.5
	1	2	3	18.5	13.0	15.0	10.0
	1	2¼	3	16.5	12.0	13.5	9.5
	2	2¼	3	14.0	13.5	11.0	8.0
	2	2¼	4	10.0	6.0	10.0	4.0
	2	2¼	5	5.0	2.5	4.5	1.0
Headed-back	1	2	1	22.5	15.0	18.0	12.5
	1	2	2	20.0	14.0	12.5	11.0
	2	2¼	2	18.5	13.0	15.0	10.0
	2	2¼	3	15.0	13.0	11.5	7.5
	2	2¼	4	7.5	4.0	7.0	3.0
Unpruned	1	2	3	18.0	11.5	15.5	9.5
	1	2	4	16.5	11.0	12.5	8.5
	2	2	3	11.5	6.5	9.0	4.5
	2	2	4	7.5	4.0	6.5	2.5
	2	2	5	5.5	2.0	4.0	1.5

Table 24—Elberta: Increase in size, three pruning treatments combined (Boxelder Experimental Farm, 1932).

	DATE MEASURED				
	Aug. 25	Sept. 1	Sept. 8	Sept. 15	Sept. 22
Picking No.	0	0	1	2	3
Maturity of Fruit	Very immature	Immature	Green to hard ripe	Firm ripe	Soft ripe
Minimum Diameter (in.)	1.67	1.83	2.06	2.22	2.32
Increase in Diameter*	...	0.15	0.22	0.15	0.12
Percentage Increase					
Over August 25	...	9.2	23.0	32.6	39.0
Over September 1	...	...	12.6	21.4	27.2
Over September 8	...	...	...	7.9	13.0
Volume**	2.90	3.21	4.58	5.73	6.54
Increase in Volume*	...	0.31	1.37	1.15	0.81
Percentage Increase					
Over August 25	...	10.7	58.0	97.6	125.4
Over September 1	...	...	42.7	78.5	103.7
Over September 8	...	...	...	25.2	42.8

*By weekly periods.

**Calculated as sphere of diameter.

The data show that growth continues until the soft-ripe stage, although it appears to reach its peak as the fruit begins to ripen and to decrease as ripening proceeds. In diameter, the fruit increased 7.9 per cent between the first and the second pickings and 13 per cent between the first and the third. In volume (calculated as a sphere), the corresponding increase was 25.2 and 42.8 per cent, respectively. From August 25 to September 22 (4

weeks) the fruit increased 125 per cent in calculated volume. While the increase from the first to the third picking was not as striking as that shown by the 1928 data, the 1932 figures are believed to be more accurate because no fruit was removed from the tree during the period of measurement.

Results. Table 25 summarizes the data on color, size, and pressure of each lot at harvest, in relation to color, quality, and condition of each lot after storage.

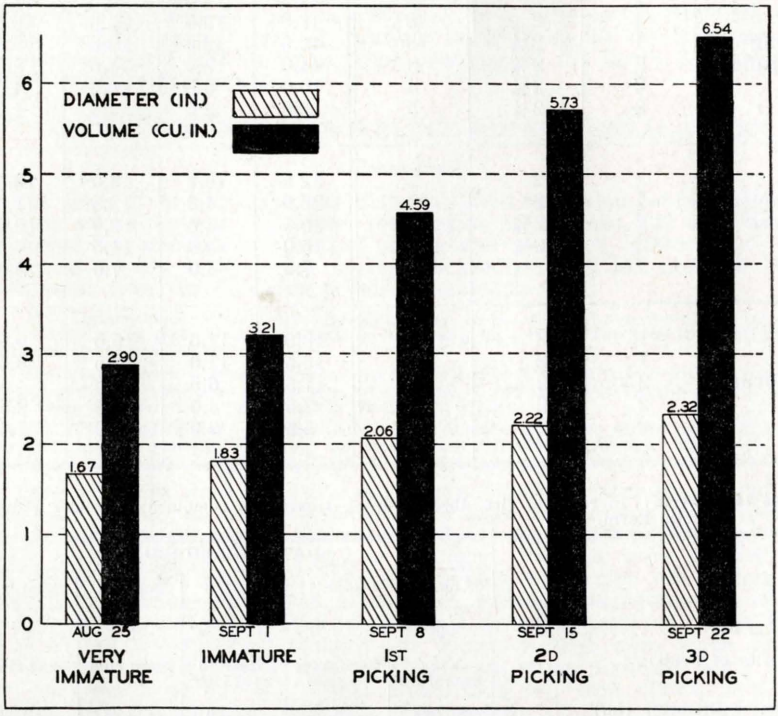


Figure 12—Increase in Size of Elberta Peaches preceding and during Harvest, 1932—Average of three pruning treatments, Boxelder Experimental Farm. Shaded bars represent average minimum transverse diameter; black bars represent corresponding volume (calculated as a sphere).

Descriptions of Experimental Lots

After storage fruit from long-pruned trees presented the most pleasing appearance of any treatment. Lots classified as Color No. 3 of the first picking (sulfur yellow when picked) and lots in Colors Nos. 3 and 4 of the second picking (sulfur yellow to amber yellow when picked) were especially attractive, showing practically no green color when removed from storage; for their high color they were also quite firm, considering the length of storage. Unpruned lots were also quite firm for their high color; however, these peaches were smaller in size, even though the same cultural and thinning treatments had been given. Fruit from headed-back lots was comparativly unattractive, being greener in color, objectionably fuzzy, and in no case better than fair in quality.

Long-pruned Series[9]. Fruit of the first picking, grading 2 and 2¼ inches in minimum size, was sorted into lots representing Colors Nos. 2 and 3.

[9]Pressure tests given in pounds represent the average of both unpeeled cheeks.

Table 25—Elberta: Color and pressure tests for each picking as related to color, quality, and condition after storage from different pruning treatments. (Boxelder Experimental Farm, Brigham, 1932.)

Treatment		Tests at Harvest			Tests after Storage			Remarks
Pruning	Picking	Size (in.)	Color No.	Pressure Test* (lbs.)	Color	Quality	Decay (%)	
Long-pruned	1st	2	2	21.5	Mostly amber yellow	Poor	0	Immature
	"	2	3	18.5	Amber yellow to corn yellow	Fair to good	1	Firm for high color; good red color, 15-33%
	"	2¼	3	16.5	Amber yellow to corn yellow	Fair to good	2	Same as above
	2d	2¼	3	14.0	Amber yellow	Fair	3	Color somewhat dull
	"	2¼	4	10.0	Corn yellow to Mirabelle	Good to excellent	0	Best quality of this treatment
	"	2¼	5	5.0	Mirabelle	Excellent	45	Heavy decay
Headed-back	1st	2	1	22.5	Greenish yellow to sulfur yellow	Sour, very poor	3	Immature, fuzzy, unattractive
	"	2	2	20.0	Sulfur yellow	Poor to fair	1	Unattractive, greenish cast
	"	2¼	2	18.5	Sulfur yellow and amber yellow	Poor to fair	0	Subacid to slightly sweet
	"	2¼	3	16.0	Amber yellow and corn yellow	Fair	33	Heavy decay
	2d	2	2	19.0	Mostly sulfur yellow	Poor	0	Green, fuzzy, unattractive, clingstone
	"	2¼	2	18.0	Sulfur yellow and amber yellow	Poor	0	Dull and unattractive, clingstone
	"	2¼	3	15.0	Amber yellow to corn yellow	Fair	0	Semi-clingstone
	"	2¼	4	8.0	Corn yellow	Good	0	Badly bruised
Unpruned	1st	2	3	18.0	Amber yellow to corn yellow	Fair to almost good	0	Attractive appearance, excellent condition
	"	2	4	16.5	Corn yellow to Mirabelle	Good to very good	0	25-50% red color; best quality of this picking
	2d	2	3	11.5	Amber yellow to corn yellow	Fair	1	Only slightly sweet
	"	2	4	7.5	Corn yellow to Mirabelle	Good	0	Very beautiful; red color, 25% to 75%
	"	2	5	5.5	Mirabelle	Good	50	Heavy decay

*Pressure test for unpeeled cheeks.

The Color No. 2 lots (greenish yellow and testing 17 to 22 pounds with 21 pounds average when picked) were mostly sulfur yellow and amber yellow with a greenish cast when removed from storage. They were subacid to slightly sweet, poor in quality, and had little or no decay.

No. 3 color lots (sulfur yellow in color and testing 9 to 25 pounds, with average of 17 and 18 pounds when picked) were surprisingly firm for their high color (amber yellow to corn yellow) and had good red color, averaging 15 to 33 per cent on most fruits. They were mostly moderately sweet, fair to good in quality, and with little bruising and decay.

Fruit of the second picking was divided into Colors Nos. 3, 4, and 5, all of the 2¼-inch minimum size. The lot represented by Color No. 3 (sulfur yellow and testing 9 to 20 pounds, with an average of 14 pounds when picked) was amber yellow in color, dull in tone, mostly slightly sweet, fair in quality; it was badly bruised, probably due to rolling about in an unfilled container, and showed 3 per cent decay.

Peaches in Color No. 4 lot of the second picking (amber yellow and testing 7 to 17 pounds, with an average of 10 pounds when picked) after storage were highly attractive, having a corn yellow to Mirabelle ground color and from 25 to 50 per cent red color on each peach. Fruit was moderately sweet to sweet and of good to excellent quality (the best quality of any lot tested although nearly equaled by Colors Nos. 4 and 5 of the unpruned series). There was no decay, although 24 per cent slight to moderate bruising was evident.

Color No. 5 lot was corn yellow, with an average pressure of 5 pounds when picked; after storage it was nearly all Mirabelle in color and was of excellent quality although soft and badly decayed.

Headed-back Series. The first picking was divided into Colors Nos. 1, 2, and 3, with 2-inch and 2¼-inch sizes in some colors.

Color No. 1 lot (green and testing 19 to 26 pounds with an average of 23 pounds when picked) showed greenish yellow to sulfur yellow, with little red color when removed from storage; the peaches in this lot were sour, extremely poor in quality, and contained 3 per cent decay. This lot was evidently much too immature for harvesting.

Peaches in Color No. 2 lots (greenish yellow and testing 15 to 22 pounds with averages of 18.5 and 20 pounds when picked when removed from storage) were sulfur yellow with a few amber yellow fruits and were unattractive in appearance, being greenish and fuzzy; the flavor was subacid to slightly sweet; quality was poor to fair; there was slight decay.

The fruit in Color lot No. 3 (sulfur yellow and with 16 pounds' average pressure test when picked) was amber yellow to corn yellow when removed from storage, slightly sweet with some bitterness, fair in quality, with heavy decay (33 per cent). This large amount of decay, however, should not be regarded as typical, since a later lot testing only 8 pounds (although soft after storage) showed no decay.

Fruit of the second picking from the headed-back trees graded from No. 2 to No. 5 (greenish yellow to corn yellow in color); all lots were 2-inch and 2¼-inch minimum sizes.

No. 2 color lots (sulfur yellow and testing 14 to 25 pounds, with 18- and 19-pound averages when picked) when removed from storage were dull and unattractive, with little red color and from sulfur yellow to amber yellow in ground color; they were subacid to neutral or slightly sweet, poor in quality, clingstone, and had no decay.

When picked, No. 3 color lot was sulfur yellow and tested 9 to 19 pounds, with an average of 15 pounds. When removed from storage, the fruit of this lot was amber yellow to corn yellow; its appearance was fair but more or less fuzzy. In quality it was fair, being slightly to moderately sweet and semi-clingstone; there was no decay.

No. 4 color lot (amber yellow and testing 7 to 13 pounds, with an average of 8 pounds) when picked was badly bruised and discolored. The color was corn yellow and the quality good.

Unpruned Series. The fruit of the first picking was sorted into 1¾-inch and 2-inch minimum sizes, the 2-inch size only being used for the storage test. Colors Nos. 3 and 4 represented the first picking.

The fruit of No. 3 color lot was sulfur yellow when picked; it tested 15 to 21 pounds, with an average of 18 pounds. When taken from storage it presented an attractive appearance, being amber yellow to corn yellow, with only a slight greenish cast left in the ground color, while the fruit itself showed considerable red color. The quality was fair (almost good), the flavor being slightly sweet, with some astringency; some of the fruits were clingstone; the condition was excellent, with practically no bruises and no decay.

No. 4 color lot (amber yellow when picked and testing 14 to 21 pounds, with an average of 16 pounds) after storage showed high color (corn yellow to Mirabelle) with scarcely any green hue. The red color was also good, averaging 25 to 50 per cent on each fruit. Quality was good to very good, the flavor being mostly moderately sweet to sweet; there was some astringency; stones were partially clinging. This lot had the best quality of any lot represented by this same treatment and picking.

The second picking was classified into the same sizes as was the first (1¾ inches); Color lots Nos. 3, 4, and 5 were represented.

Color lot No. 3 (sulfur yellow when picked and testing 9 to 17 pounds, with an average test of 12 pounds) when removed from storage was amber yellow to corn yellow. Quality was only fair, being but slightly sweet; there was a slight amount of bruising and decay.

Color lot No. 4 (amber yellow and testing 5 to 12 pounds when picked, with an average of 7.5 pounds) when removed from storage was especially beautiful in coloration. The ground color was mostly corn yellow and Mirabelle, with from 25 to 75 per cent red color on each fruit. The quality was good, the flavor being moderately sweet; there was a small amount of bruising but no decay.

Color lot No. 5 showed corn yellow when picked and tested from 3 to 9 pounds, with a 5-pound average. When removed from storage the peaches were highly colored, all showing Color No. 6 (Mirabelle). The flavor was sweet and slightly astringent, rating good in quality. However, this lot was extremely soft and about half of the fruits were decayed.

Data for pressure-test averages, quality, and condition for each color, regardless of picking or size of fruit are summarized in Table 26. Details have purposely been omitted in order to feature the essential data. Where

a range of pressure tests is given, the lower figure represents lots of the second picking.

Table 26—Elberta: Relation between color, pressure, quality, and condition of fruit from different treatments (Brigham, 1932).

Pruning Treatment	Color No.	Pressure Avg. (lbs.)	Quality	Condition
Long-pruned	2	21.5	Poor	O. K.
	3	14.0-18.5	Fair to good	O. K.
	4	10.0	Good to excellent	Somewhat soft
	5	5.0	Excellent	Heavy decay, soft
Headed-back	1	22.5	Poor, sour	O. K.
	2	18-20	Poor to fair	O. K.
	3	15-16	Fair	One lot O. K. One lot heavy decay
	4	8.0	Good	Soft, badly bruised
Unpruned	3	11.5-18.0	Fair	O. K.
	4	7.5-16.5	Good	Lower pressure lots somewhat soft
	5	5.5	Good	Heavy decay, soft

Discussion of Pressure and Color Tests. In the long-pruned series, the best pressure-test range for unpeeled cheeks apparently was from 12 to 18 pounds' pressure. This corresponds to from about 8 to 10 pounds on the peeled suture, or from 10 to 13 pounds on the unpeeled suture. Most of this lot was classified as Color No. 3 (sulfur yellow). The greener fruits of the second picking (No. 3, sulfur yellow) were not as attractive nor of as good quality as fruit of the same color of the first picking.

The fruit of Color No. 4, which tested 10 pounds, was the most attractive and the best in quality; if shipped by ordinary methods, however, it probably would have been somewhat too soft for rehandling. Such fruit could probably be kept firm by precooling or by adding salt to the ice when first loaded to more rapidly cool the fruit. Picking and loading in the early morning or allowing the fruit to cool in the orchard overnight would also be helpful.

Fruit from heavily headed-back trees was somewhat later in maturing, which made it difficult to compare directly with fruit from other treatments. As measured by its pressure test, this fruit was greener in color for its softness than was fruit from long-pruned trees. From data secured, a pressure-test range of from 12 to 16 pounds and Color No. 3 (sulfur yellow) would appear to be best. Fruit reaching Color No. 4 (amber yellow) was too mature.

Fruit from unpruned trees proved to be more mature than that from the other two treatments. The best lot averaged 16.5 pounds' pressure, while the 18-pound lot ranked fair (almost good) in quality. The good condition of a lot testing 7.5 pounds which had no decay but was somewhat soft indicates that a lower limit of 10 pounds' pressure for fruits from this type of tree would probably be safe. The second picking was largely too mature, except for fruits in Color No. 3 lot; these were inferior in quality.

The experiment shows that fruit from both heavily headed-back and unpruned treatments was unsatisfactory, the former being low in quality, poorly-colored, and objectionably fuzzy; the latter fruit (from unpruned trees) failed to reach the desired 2¼-inch minimum size, even though thinned as heavily as the long-pruned trees.

Chemical Anaylsis. As noted under Procedure, samples of peaches of each lot tested and stored were preserved for chemical analysis. The object of this phase of experimentation was to ascertain to what extent the carbohydrate content (particularly sugars) and the total nitrogen content varied between treatments, as well as what the correlation was between time of picking, color and pressure as indexes of picking maturity, sugar content (which largely determines quality), and insoluble carbohydrates (which may also affect firmness and carrying quality).

For this study it was not possible to get fruit of the same size and color, since fruit from the different treatments varied in these respects. It was first planned to analyze three peaches of each lot separately, one representing the highest, one the lowest, and one the average pressure test for each lot with a view of comparing directly pressure test and sugar and insoluble carbohydrate content. Later, this plan was found to be impractical, so the three samples from each lot were combined.

CHEMICAL METHODS USED

Sampling

In each sample 150 grams of fresh peach tissue were used. These contained 50 grams of flesh from each of three fruits, preserved in approximately 600 cc. of 95 per cent alcohol. The alcohol was brought to a boil; a pinch of sodium carbonate was added to neutralize the acid in the fruit; it was then removed from the stove and the sliced peach tissue dropped in. The bottles were then sealed for later analysis, this analysis being completed on January 5, 1933.

Analysis

Each sample was first filtered. The solid material was then crushed and washed 8 to 10 times with 70 per cent alcohol, the washings being added to the filtrate of the original. The solid material was dried on a water oven at 95° C., weighed as insoluble residue, and then ground fine. The filtrate and washings were brought to 1000 cc., with 70 per cent alcohol for later analysis.

Ash. Duplicate samples containing one-tenth of the alcohol solution were evaporated to dryness. One-tenth of the insoluble residue was then added to each; they were then burned to constant weight in a muffle furnace.

Soluble Nitrogen. Duplicate samples consisting of 100 cc. of the alcohol solution were evaporated under negative pressure to 2 to 3 cc. Analysis was then made, using Ranker's modification of the Gunning Method (O. T. M. A.) (1930). N/14 HCl was used in the distilling process. Back-titration was accomplished by using N/14 NaOH. The amount of nitrogen was then read in milligrams directly from the burettes.

Insoluble Nitrogen. 0.5-gram samples of the insoluble residue were analyzed in duplicate by the Gunning-Kjeldahl process (1930), the same titration methods being used as for soluble nitrogen.

Sugar. Both total and reducing sugars were determined by analyzing 25 cc. of the alcohol solution by Willaman's and Davison's picric acid method (1924).

Protein. Protein was calculated by multiplying the insoluble nitrogen by the factor 6.25.

Insoluble Carbohydrate. Insoluble carbohydrate was determined by subtracting ash and protein from the insoluble residue.

Results of Chemical Analyses

Table 27 presents percentages (green-weight basis) of reducing, non-reducing, total sugars and alcohol-soluble nitrogen, alcohol-insoluble nitrogen, total nitrogen, protein, ash content insoluble and total carbohydrates.

Table 27—Elberta: Reducing, non-reducing, total sugar, insoluble and total carbohydrates; nitrogen, protein, and ash content of different colors and sizes from different pruning treatments (percentage of green-weight basis) (Brigham, 1938).

Treatment	Size (in.)	Color	Pick-ing	Sugar			Carbohydrates		Alcohol Soluble N.	Alcohol Insoluble N.	Total N.	Insoluble N. as Protein	Total Ash (%)
				Reducing	Non-reducing	Total	Insoluble	Total					
Long-pruned	2	2	1st	3.6	6.2	9.8	1.97	11.8	.039	.046	.085	.29	.39
	2	3	1st	2.8	7.2	10.0	1.95	12.0	.037	.047	.084	.29	.35
	2¼	3	2d	2.8	8.2	11.0	1.5	12.5	.034	.038	.072	.24	.36
	2¼	4	2d	3.1	9.1	12.2	1.7	13.9	.027	.040	.067	.25	.40
	2¼	5	2d	3.3	9.0	12.3	1.84	14.2	.029	.043	.072	.27	.44
Average				3.12	7.94	11.06	1.79	12.85	.033	.043	.076	.27	.388
Headed-back	2	1	1st	3.35	5.5	8.85	1.83	10.86	.066	.049	.115	.31	.41
	2	2	1st	3.1	6.6	9.7	1.7	11.40	.050	.050	.100	.32	.40
	2¼	2	2d	2.5	8.3	10.8	2.1	12.9	.051	.055	.106	.34	.39
	2¼	3	2d	3.0	8.0	11.0	1.89	12.9	.045	.050	.095	.31	.39
	2¼	4	2d	2.7	7.8	10.5	1.74	12.24	.033	.036	.069	.23	.34
Average				2.93	7.24	10.17	1.85	12.02	.049	.048	.097	.302	.386
Unpruned	2	3	1st	3.0	6.2	9.2	1.97	11.17	.036	.041	.077	.25	.33
	2	4	1st	2.5	6.8	9.3	1.81	10.11	.028	.036	.064	.22	.32
	2	3	2d	2.5	6.5	9.0	1.85	10.85	.043	.040	.083	.25	.38
	2	4	2d	3.0	7.3	10.7	1.66	12.36	.019	.033	.052	.21	.36
	2	5	2d	2.7	7.5	10.2	1.58	11.78	.018	.032	.050	.20	.36
Average				2.54	7.14	9.68	1.78	11.46	.029	.036	.065	.226	.35

Sugars and Carbohydrates. The data indicate a gradual increase in percentage of total sugars from the less mature lots, as evidenced by the ground color (as well as by pressure tests, Tables 25, 26, and 27) to the more mature lots. In the long-pruned lots, sugar increased from 9.8 per cent in the greenest lot of the first picking to 12.3 per cent in the highest colored lot of the second picking, an increase of 25 per cent (green-weight basis). These percentages are somewhat higher than those shown by Bigelow and Gore (1905), who give 8.61 per cent total sugar for market-ripe Elbertas and 9.60 per cent for full-ripe Elbertas.

While headed-back lots show a similar increase of 24 per cent, unpruned lots show an increase of only 16 per cent. Most of this increase is in non-reducing sugars, principally sucrose, since reducing sugars show no consistent increase; neither do insoluble carbohydrates show any consistent trends.

Comparing these three pruning treatments, the average of all lots from long-pruned trees showed the highest total sugar content (11.06 per cent), while the headed-back treatment ranked second with 10.17 per cent; and the unpruned treatment ranked last with 9.68 per cent. Fruit from long-pruned trees had 9 per cent more sugar than from headed-back trees and 14 per cent more than fruit from unpruned trees. The headed-back treatment resulted in 5 per cent more sugar than the unpruned treatment.

Nitrogen and Protein. There appeared to be a distinct decline of alcohol-soluble nitrogen as the maturity advanced, although this is more marked in the riper lots. There appeared to be little, if any, decline in alcohol-insoluble nitrogen and consequently in protein.

Fruit from headed-back trees was distinctly higher in total nitrogen, averaging 0.097 per cent, as compared with 0.076 per cent for the long-pruned and 0.065 per cent for the unpruned. These data indicate that differences exist in the nitrogen content which may affect both size and maturation of the fruit; there appears to be, therefore, some justification for calling heavily headed-back trees "high nitrate" in growth status, the unpruned trees "low nitrate," and the long-pruned trees "intermediate" in growth status.

The relative percentage composition of total carbohydrates, however, does not justify referring to fruit from unpruned trees as "high carbohydrate" since the fruit from these trees was appreciably lower than either of the other treatments, the average percentage composition of long-pruned, headed-back, and unpruned fruit being 12.85, 12.02, and 11.46 per cent, respectively.

B. EXPERIMENTS ON DAVIS EXPERIMENTAL FARM[10]

Objects

In addition to comparing maturity indexes of J. H. Hale and Early Elberta with those of Elberta, which was the primary object of these experiments, determination was made of maturity indexes desirable for fruit handled by precooling.[11]

Procedure

Age and Condition of Trees. Elberta, Early Elberta, and J. H. Hale peaches used in this experiment, were harvested from a block of 45 young trees of these varieties in their fifth growing season on the Davis Experimental Farm. These trees, planted in 1928, had made a vigorous growth and bore a moderate crop in 1931. The bloom and set in 1932 was heavy;

[10]Near Farmington, Utah.

[11]Precooling is the practice of removing the field heat from the fruit and bringing it to refrigeration temperatures without the usual delay of 48 hours to 72 hours encountered in a refrigerator car loaded with hot fruit, by placing the fruit in cold storage prior to loading, or by the use of blowing machines, which cool the fruit by forced rapid air circulation through the ice and fruit in the loaded iced car.

in spite of moderate thinning, however, much of the fruit failed to make the desired 2¼-inch minimum size. The heavy crop reduced the vigor of growth markedly over previous years, especially in the Early Elberta. The trees have been pruned almost entirely by thinning out in previous years. Under this system, at the end of the fourth year the trees had reached a height and spread of 10 to 14 feet. In the spring of 1932, the trees were again pruned by thinning out the branches, while in alternate rows the highest branches were moderately cut back.

Harvesting. Fruit was harvested from six trees of each variety at each picking. After sizing, the fruit was classified according to color standards, red-color records of each peach also being taken. Two duplicate lots were made, one for precooling (prompt storage, at a refrigeration temperature of 50° F.); the other for delayed storage (intended to duplicate commercial conditions where fruit is exposed to a delay of 72 hours before reaching refrigeration temperature), followed by storage at 50° F. Approximately 24 hours' delay occurred in sorting and testing in the field, after which the precooled lots were stored promptly in commercial cold storage at Ogden (18 miles north); delayed lots were held at 60° to 65° F. for two days before storage (50° F.).

Pickings were made on September 11, 15, and 20. Fruit was removed from storage on October 7 and hauled in a 1½-ton truck to Logan (50 miles distant); records were taken on October 8. Hauling after storage caused much bruising of fruit in the softer lots.

Results

Relation of Red Color to Time of Picking. The amount of red color on each fruit was noted, after picking, by classifying the peaches into four groups according to their red colors: (1) No color; (2) trace (5-20%); (3) one-fourth (20-30%); and (4) one-third or over. These data are summarized in Table 28.

Table 28—Elberta, Early Elberta, and J. H. Hale: Red color of peaches as related to time of picking (Farmington, 1932).

Variety	Picking Date	Red Color (% Fruits in Each Group)				Average Color (%)
		None (0%)	Trace (5-20%)	One-fourth (20-30%)	One-third (Over 33%)	
Elberta	Sept. 11	0	70	30	0	14.5
	" 15	2.0	50.7	19.2	28.1	23.9
	" 20	0	26.9	28.1	50.0	34.0
Early Elberta*	" 6	8.2	56.9	26.9	6.5	15.5
	" 10	3.1	56.6	22.0	18.3	20.2
J. H. Hale*	" 11	2.8	52.3	23.6	21.3	22.8
	" 15	2.6	24.0	36.9	37.0	29.7

*Colors for the last picking not ascertained.

The average percentage of red color (Elberta) increased from 14.5 per cent in the first picking (September 11) to 23.9 per cent in the second picking (September 15) and to 34 per cent in the third picking (September 20).

Relation of Red Color to Ground Color. The average amount of red color for each variety and picking (as percentage of red color on each peach) is given separately for each ground color or undercolor in Table 29.

As would be expected, the amount of red color is higher in the more advanced ground color lots.

Table 29—Elberta, Early Elberta, J. H. Hale: Relation of red color to ground or undercolor (Farmington, 1932).

Varietv	Picking Date	AVERAGE PERCENTAGE OF RED COLOR* GROUND COLOR NO.**			
		2	3	4	5
Elberta	Sept. 11	13.0	22.0	...	...
	" 15	13.6	19.8	41.1	...
	" 20	...	16.9	29.8	47.0
Early Elberta	" 6	8.8	18.0	28.1	...
	" 10	...	11.4	17.0	40.9
J. H. Hale	" 11	15.8	26.8	43.3	...
	" 15	...	...	20.3	44.1

*Average of amounts of red color on each peach in lot.

**Color chart, Plate 1.

Percentages of fruit of each color lot, as well as the percentages for each picking as a whole, of fruit which meets or exceeds the minimum red color requirement for the U. S. Fancy grade (25 per cent) are given in Table 30.

Table 30—Elberta, Early Elberta, J. H. Hale: Percentage of fruit in each color lot grading U. S. Fancy as to red color (25 per cent red color required) (Farmington, 1932).

Variety	Picking Date	COLOR LOT NO.				% of Entire Picking
		2	3	4	5	
Elberta	Sept. 11	0	0	...	...	0
	" 12	13.1	42.4	88.5	...	48.7
	" 20	...	28.9	75.3	97.1	73.0
Early Elberta	" 6	8.0	32.8	73.2	...	34.6
	" 10	...	20.5	34.8	72.4	43.7
J. H. Hale	" 11	28.6	59.3	95.5	...	44.5
	" 15	...	...	57.4	92.4	70.4

It is noteworthy that the percentage of peaches of Fancy color increased materially as the harvesting was delayed. With Elbertas, the percentage of fancy fruit increased from 0 to 48.7 per cent from the first to the second picking and to 73 per cent in the third picking. Early Elbertas similarly increased from 34.6 to 43.7 per cent fancy color, while J. H. Hales increased from 44.5 to 70.4 per cent. The use of precooling to permit picking at a more mature stage would help to make possible production of a high percentage of U. S. Fancy grade peaches.

In the second and third pickings the percentage of red color in relation to the ground color was lower than in the first picking. For example, the average percentage of color of J. H. Hale fruits of the Color No. 4 lot of the first picking was 43.3, while the fruit of the same ground color of the second picking had only 20.3 per cent color. Again, the Color No. 4 lot of the first picking of Early Elberta graded 88.5 per cent U. S. Fancy as to color (25 per cent red color required), while the comparable lot of the second picking had only 34.8 per cent Fancy. A possible explanation suggested by the lower percentage of red color in fruit picked later, as borne out by

observation, is that this later ripening fruit may come from shaded portions of the tree. If this is the case, it is probable that shading retards the development of yellow as well as red color. Retarded yellow-color development in fruit of heavily headed-back trees, in which the fruit and fruiting wood was heavily shaded with new growth, would substantiate this theory. Furthermore, yellow carotinoid pigment is not evident until chlorophyll disappears (Addoms, 1930), and chlorophyll disintegration take place most rapidly in direct sunlight. Observations indicate that peaches in direct sunlight show higher color for their firmness than those in the shade.

Figure 13—Above: A long-pruned Elberta peach tree (Boxelder Experimental Farm). Note the excellent exposure to light of fruit and fruiting twigs compared to the headed-back tree below. Fruit from these trees was more attractive, had a higher ground color, more red color, higher sugar content, and better flavor than fruit from headed-back trees.

Below: A headed-back Elberta peach tree. Note heavy shading of fruit and fruiting branches by vigorous new growth. Fruit did not develop as high a ground color at the same stage of maturity, was fuzzier and less attractive; had higher nitrogen and lower sugar content, and was poorer in flavor than fruit from long-pruned trees. Such fruit should be picked with a greener color than that better exposed to light; with this type of fruit the pressure test is a more accurate index of maturity than is ground color.

In the 1932 results with the Farmington Elberta and J. H. Hale varieties, fruit from later pickings, even though of the same ground color and lower pressure test, was inferior in quality to fruit from earlier pickings. This can be accounted for by the same hypothesis: That such fruits come from shaded branches such as shown in Fig. 13 (lower) where less carbohydrate synthesis takes place. For example, Color No. 4 lot of the second picking of Elberta was rated "excellent" in quality, while the corresponding color lot of the third picking rated only "fair to good" in quality. In most of the tests fruit which colored first combined the best dessert and carrying quality with the most attractive appearance. The findings of Morris (1932) are in agreement with this conclusion. In the production of this desirable type of fruit it is possible that sunlight and the absence of shade play a greater part than the nutritional or "growth status" of the tree as concluded by Blake (1931). Blake's "high-nitrate" tree, as illustrated in his Figure 2 (N. J. Bul. 525) had a dense top and most of the fruit apparently grew in the shade. Fruits from this tree in 1929 ". . . never really attained attractive marketing color . . ." It is possible that this failure may have been due more to the shaded condition than to the "high-nitrate" growth status.

Results with Elberta Peaches

Results with precooled lots of Elberta peaches in comparison with delayed lots are given in Table 31.

Descriptions of Elberta Lots

First Picking—Fruit of the first picking was classified as Color No. 3, although most of it lay between Colors Nos. 2 and 3 (greenish yellow to sulfur yellow) and tested 17.5 pounds. Fruit of the precooled lot, while mostly amber yellow after storage, had considerable green color and was not attractive in appearance. Flavor varied from sour to moderately sweet, most of the fruit being slightly sweet and fair in quality. The delayed lot was similar, except for unusually heavy spoilage (15 per cent).

Second Picking—Color No. 2 lots (greenish yellow and testing 14.5 pounds when picked) were mostly amber yellow with some greenish cast persisting and was mostly fair in quality; most of the fruit lacked sweetness or was slightly sweet. The delayed lot had 4 per cent decay and 10 per cent bruised and over-ripe fruit, while the precooled lot had only 0.5 per cent decay and 8 per cent over-ripe and bruised fruit.

Color No. 3 lots (sulfur yellow, testing 14 pounds when picked) when removed from storage became Color No. 4 (amber yellow) and were mostly slightly sweet. The delayed lot had 15 per cent decayed and 50 per cent over-ripe or bruised fruit. The precooled lot had 5 per cent decay and 44 per cent bruised or over-ripe fruit (mostly bruised).

Color No. 4 lots (amber yellow and testing 12 pounds when picked) was a most attractive color (corn yellow and Mirabelle) when taken from storage. Both lots were of excellent quality, being moderately sweet to sweet. The delayed lot, however, had 15 per cent decay and 24 per cent over-ripe fruit. The precooled lot had only 0.5 per cent decay but had 65 per cent slightly to moderately bruised and over-ripe fruit.

Third Picking—Of the Color No. 3 lots of the third picking (sulfur yellow and 10.5 pounds when picked), the delayed lot was mostly amber yellow in color, unattractive, and fair to good in quality, being neutral to moderately sweet in flavor. Thirteen per cent of the fruit was bruised, with no decay. The precooled lot was somewhat greener than the delayed lot. The flavor of the greener fruits was subacid to slightly sweet, resulting in fair quality, while the more highly-colored fruits were sweeter and of better quality. In this lot there were few bruises and no decay.

Color No. 4 lots (amber yellow and 8.5 pounds' pressure when picked), when examined after storage were amber yellow to corn yellow with mostly corn yellow in the delayed lot. The flavor of both lots was neutral to sweet, mostly slightly to moderately sweet, and rated as fair to good, being mostly good in quality. The delayed-storage lot contained 0.5 per cent decay and 25 per cent badly bruised fruit. The precooled lot showed 4 per cent decay and 75 per cent bruised fruit, most of which, however, was only moderately bruised.

Color No. 5 lots (corn yellow and testing 7.5 pounds when picked) showed a highly attractive color (corn yellow and Mirabelle), were sweet, good to excellent in quality but were soft. The delayed lot had only 1 per cent decay but showed 61 per cent bruised and over-ripe fruit; the precooled lot had 18 per cent decay and 51 per cent badly bruised fruit. These lots were much too ripe for shipment.

Discussion of Elberta Results

Unfortunately the length of the storage period (18 to 28 days) makes it impracticable to use firmness of fruit upon withdrawal from storage as an index of its shipping quality before storage, except in a comparative

way. It also greatly reduces the value of the comparison of over-ripe and bruised fruit between the different lots, since this storage period is three to six times the period usually required for Utah peaches to reach market. In many cases the firmer and more immature lots of fruit were as soft as the riper lots after storage. This tendency for the greener lots to soften at a faster rate is shown in Figure 6. In view of this difference between time of storage and that required for transportation, it is hardly likely that the percentages of decay and of bruised and over-ripe fruit would be as high under actual shipping conditions. It is also likely that the 72-hour delay in storage in the delayed lots (which included 24 hours of field temperatures with a maximum of 95° F. and 48 hours' delay at 65° F.) probably was more severe than conditions usually encountered in the shipping of peaches. The sorting, classifying, testing, and color record-taking caused a much greater delay than is encountered in commercial shipping, where fruit is frequently loaded within a few hours after picking.

Table 31—Elberta: Harvesting indexes in relation to condition and quality (stored within 24 hours) (Farmington, 1932).

Picking		Harvesting Indexes		Quality and Condition after Storage				Remarks
No.	Date	Pressure[a] (lbs.)	Color	Color	Quality	Decay (%)	Bruised and[b] Over-ripe (%)	
				Precooled Lots				
1	Sept. 11	17.5	2.5	Sulfur yellow to amber yellow, mostly amber yel.	Poor to fair, mostly fair	0	0	Unattractive, greenish cast
2	" 15	14.5	2	Sulfur yellow and amber yellow	Poor to good, mostly fair	.5	8[c]	Greenish cast; greenest fruit sour
2	" 15	14.0	3	Mostly amber yel.	Fair to good	5.0	44[c]	
2	" 15	12.0	4	All corn yellow and Mirabelle	Good to excellent	.5	65[c]	Highly attractive color
3	" 21	10.5	3	Sulfur yellow to amber yellow, mostly amber yel.	Fair to good	0	0	Greenish appearance, firmer than Color No. 4
3	" 21	8.5	4	Amber yellow and corn yellow	Good	4	75[c]	Slight greenish cast, moderately attractive
3	" 21	7.5	5	Corn yellow to Mirabelle, mostly Mirabelle	Good	18	51	Quite soft
				Delayed Lots				
1	Sept. 11	17.5	3	Sulfur yellow to amber yellow	Fair	15.0	0	Greenish—unattractive
2	" 15	14.5	2	Mostly amber yellow	Mostly fair	4.0	10[c]	
2	" 15	14.0	3	Amber yellow	Fair to good	13.0	50[c]	
2	" 15	12.0	4	Corn yellow and Mirabelle	Excellent	15.0	24	Attractive, but soft and bruised
3	" 21	10.5	3	Mostly amber yellow, some corn yellow	Fair to good	0	13[c]	Unattractive
3	" 21	8.5	4	Amber to corn yellow, mostly corn yellow	Fair to good, mostly good	.5	25	.....
3	" 21	7.5	5	Corn yellow to Mirabelle	Excellent	1.0	61	Badly bruised—soft

[a]Pressure tests for unpeeled cheeks.

[b]Excessive bruising caused by hauling in unfilled containers.

[c]Slightly to moderately bruised.

Results, in general, indicate that Elberta peaches with a pressure test of 14 to 18 pounds should arrive in a satisfactory condition and should develop fair quality. Peaches of 10 pounds' pressure test (or even as low as 8.5 pounds' test) may be shipped satisfactorily by the use of precooling or some other method of promptly cooling the load to a refrigeration temperature of 50° F. Such fruit apparently develops much better sweetness, quality, and color than that picked at a greener stage. With ordinary handling, sulfur yellow appears to be the maximum safe color for this type of Elberta fruit, although fruit of amber yellow hue develops better quality and color, provided its firmness and condition can be preserved by prompt refrigeration. Fruit of Colors Nos. 5 and 6 (corn yellow and Mirabelle) is usually too ripe for shipment.

Results with Early Elberta Peaches

Harvesting indexes of precooled and delayed lots of Early Elberta peaches in relation to quality and condition after storage are given in Table 32.

Table 32—Early Elberta: Harvesting indexes in relation to condition and quality (stored within 24 hours) (Farmington, 1932).

Picking		Harvesting Indexes		Quality and Condition after Storage				Remarks
No.	Date	Pressure (lbs.)*	Color	Color	Quality	Decay (%)	Over-ripe (%)	
				Precooled Lots				
1	Sept. 6	20.0	2	Sulfur yellow	Poor	0	0	Unattractive, greenish cast; mostly clingstone
1	" 6	17.5	3	Amber yellow	Fair to good	0	0	Mostly freestone
1	" 6	15.0	4	Mostly corn yellow	Good to excellent	0	0	Slightly soft for rehandling
2	" 11	16.0	3	Mostly amber yellow	Fair	0	0	Slight greenish cast; partially clingstone
2	" 11	11.0	4	Amber yellow to Mirabelle, mostly corn yellow	Good to excellent	1	0	Attractive, good quality and condition
2	" 11	8.0	5	Corn yellow and Mirabelle	Good	12.3	50	Very soft
				Delayed Lots				
1	Sept. 6	20.0	2	Amber yellow	Poor	0	0	Clingstone, mostly sour
1	" 6	17.5	3	Amber to corn yellow	Fair to good	0	0	Mostly freestone
1	" 6	15.0	4	Corn yellow to Mirabelle	Good to excellent	50	..	Soft; heavy decay
2	" 11	16.0	3	Amber yellow	Mostly fair	9.3	44.8	Half cling or semi-cling
2	" 11	11.0	4	Corn yellow and Mirabelle	Mostly good	7.5	49.5	All freestone
2	" 11	8.0	5	Corn yellow and Mirabelle	Good to excellent	42.5	57.5	All decayed or over-ripe and badly bruised

*Pressure test figures for tests on unpeeled cheeks.

Descriptions of Early Elberta Lots

First picking. Precooled lots of the first picking were precooled for 24 hours at 32° F. and then stored for 9 days at 50° F. Delayed lots were stored for 48 hours at 60° F. (following a 24-hour delay in the orchard dur-

ing sorting and testing of both lots), and then stored for another seven days at 50° F. When removed from storage, delayed lots had advanced approximately one color over precooled lots.

Color No. 2 lot (greenish yellow and testing 20 pounds' pressure when picked) which was precooled, was sulfur yellow in color, with an unattractive greenish cast, mostly clingstone, firm, and poor in quality, with most of the fruit sour. The delayed lot had advanced to Color No. 4 (amber yellow), was slightly soft, clingstone, and of poor quality. No decay or over-ripeness was evident in either lot.

Precooled Color No. 3 lot (sulfur yellow, testing 17.5 pounds' pressure when picked) after storage was amber yellow, slightly soft, mostly freestone, flavor slightly to moderately sweet, and rated fair to good in quality. The delayed lot had a higher color (amber yellow to corn yellow) but was too soft for handling. Flavor and freedom of pit were the same as with the precooled lot.

Color No. 4 precooled lot (amber yellow and 15 pounds' pressure) was mostly corn yellow in color after storage, mostly moderately soft, freestone, with a flavor moderately sweet to sweet, its quality good to excellent, with no decay. The delayed lot was high in color but was about half decayed. Unspoiled peaches of this lot were soft to very soft, with similarly good flavor.

Discussion of First Picking. Because of the similarity of its treatment to commercial handling, first-picking results merit separate discussion. In the first picking, Color No. 4 peaches (amber yellow) had the best color and flavor but were somewhat too soft for commercial handling although highly desirable for use within 24 hours. For commercial handling, Color No. 3 fruit was superior although inferior in appearance and flavor to the more highly-colored fruit.

It is likely that with a 5-day storage period and with prompter cooling (possible in commercial shipping) that No. 4 color lot would have been sufficiently firm for commercial handling when precooled or otherwise brought quickly to refrigeration temperature (50° F.). Fruit of No. 4 color appeared too ripe for handling under ordinary refrigeration with its delay in cooling. With this treatment No. 3 color appeared to be best. No. 2 color lots were all low in quality, unattractive in color and appearance, and mostly clingstone. In the first picking, fruit of 17 and 18 pounds' pressure appeared to be suitable for ordinary delayed refrigeration; that testing 15 pounds was satisfactory when precooled but was too ripe for ordinary refrigeration.

Second Picking. The second picking was stored for 26 days, being removed for examination with Elberta and J. H. Hale peaches. Precooled lots were stored at 50° F. directly, without holding at 32° F. for a day. Duplicate lots of fruit were used in the precooling treatment.

No. 3 color lots (sulfur yellow) tested 16 pounds when picked. Precooled lots were mostly Color No. 4 (amber yellow) with considerable green color persisting, slightly soft, with a sour flavor in the greenest to moderately sweet and good in the ripest fruits; all but the greenest fruits were freestones; no decay or "over-ripes" were apparent in the precooled lot. Delayed Color No. 3 lot had about the same color, was soft, with 9.3 per cent decay and 49.7 per cent over-ripe and badly bruised peaches. Color and flavor were the same as in precooled lots.

Color No. 4 lots were amber yellow and tested 11 pounds when picked. After storage, precooled lots ranged from amber yellow to Mirabelle in color, with most of the fruit corn yellow, slightly soft, flavor moderately sweet to sweet, quality good to excellent, and freestone. One lot had 1.7 per cent decay with 7.6 per cent over-ripe and bruised peaches. The delayed lot was soft, of the same color, sweet and good in quality, with 7.5 per cent decay and 50 per cent bruised and over-ripe peaches.

Color No. 5 lots (corn yellow and 8 pounds' pressure when picked) were mostly soft to very soft and very highly colored (corn yellow and Mirabelle). The precooled lot was slightly sweet to sweet, with a flat flavor. This lot had 30.5 per cent "over-ripes" and 6.2 per cent decay. Delayed Color No. 5 lot was practically a total loss, having 43 per cent decay and 57 per cent over-ripe fruit.

Discussion of Second Picking. While the heavy proportion of over-ripe and bruised fruit in the second picking was undoubtedly increased in Color Nos. 3 and 4 lots by the long storage period, it is noteworthy that the same lots in the precooled treatment had no spoilage or over-ripe fruit, even Color No. 4 lots being in good condition. Color No. 5 lots were too ripe for shipment, even with precooling.

Results with J. H. Hale Peaches

Two pickings of J. H. Hale were made experimentally, being made at the same time as the first and second pickings of Elbertas. Results are summarized in Table 33.

Table 33—J. H. Hale: Harvesting indexes in relation to condition and quality (Farmington, 1932).

Picking		Harvesting Indexes		Quality and Condition after Storage				Remarks
No.	Date	Pressure (lbs.)*	Color	Color	Quality	Decay (%)	Over-ripe (%)	
				Precooled Lots (Stored within 24 hours)				
1	Sept. 11	17.0	2	Sulfur yellow to amber yellow, mostly amber yel.	Poor	0	0	Slightly soft; freestone
1	" 11	17.0	3	Amber yellow to corn yellow	Fair to good	0	0	Attractive red and yellow color, softer than 2
2	" 15	13.5	3	Amber yellow and corn yellow	Fair to good	0	0	Mostly firm
2	" 15	10.7	5	Mostly corn yellow to Mirabelle	Good to excellent	1.6	16 (mostly bruised)	Attractive color; mostly firm and slightly soft
				Delayed Lots (Delayed 72 hours)				
1	Sept. 11	17.0	2	Sulfur yellow to amber yellow, mostly amber yel.	Poor to fair	0	0	Freestone, slightly soft
1	" 11	17.0	3	Amber yellow to corn yellow; mostly corn yel.	Fair	0	0	Slightly softer than 2
2	" 15	13.5	4	Amber yellow to corn yellow; mostly amber yel.	Poor to fair, mostly fair	0	0	
2	" 15	10.7	5	Corn yellow to Mirabelle	Good	43	53	Moderately soft, attractive color, heavy decay

*Pressure-test figures are for tests on unpeeled cheeks.

Description of J. H. Hale Lots

First Picking—Color No. 2 lots (greenish yellow and testing 17 pounds when picked) when removed from storage were sulfur yellow to corn yellow (mostly amber yellow). They were poor to fair in quality, ranging from sour to slightly sweet, and were freestone. Both lots were in good condition, being only slightly soft with no decay or "over-ripes."

Color No. 3 lots (sulfur yellow and testing 13.5 pounds when picked) were amber yellow to corn yellow after storage, mostly slightly soft, freestone, and fair to good in quality. Neither showed any decay or "over-ripes."

Second Picking—The greenest fruit in the second picking was classified as Color No. 4 (amber yellow) and tested 13.5 pounds before storage. Both the precooled and delayed lots were amber yellow to corn yellow in color when removed, firm and slightly soft, the delayed lot being softer than the precooled lot, and mostly fair in quality. Both lots were in good condition and showed an attractive color.

Color No. 5 lots (corn yellow and testing 10.7 pounds' pressure when picked) were corn yellow and Mirabelle in color and good to excellent in quality. The precooled lot was highly attractive in color and comparatively firm, rating firm and slightly soft; it had only 1.6 per cent decay and 16 per cent bruised fruit. The delayed lot, on the other hand, was soft and badly decayed, having 43 per cent decay and 53 per cent over-ripe and bruised fruit.

Discussion of J. H. Hale Results

In this test fruit of sulfur yellow and amber yellow, testing from 12 to 17 pounds' pressure, appeared to be best for ordinary delayed refrigeration handling. The greenish-yellow colored fruit of the first picking was lacking in quality, while fruit of a corn yellow testing from 7 to 16 pounds, with an average of 10.7, appeared to be too ripe for ordinary handling. Even fruit of this advanced color, however, was satisfactory when precooled. From this experiment, the best stage of maturity would seem to be indicated by Color No. 4 and pressure-test averages from 12 to 15 pounds. Fruit somewhat greener than this developed only fair quality, while riper fruit was handled only by precooling. This range is within that indicated by the 1929 results with this variety. Under conditions for 1932, it would appear that J. H. Hale peaches, because of their greater firmness at the same color, can be safely picked at a somewhat higher color than Elbertas.

Conclusions from the 1932 Experiments

1. The amount of red color on Elberta, Early Elberta, and J. H. Hale peaches increased markedly as harvesting was delayed. The percentage of Fancy[12] color increased 52 per cent in 5 days' delay with Elbertas, 26 per cent with Early Elbertas, and 58 per cent with J. H. Hales.

2. The percentage of red color was lower with peaches of the same ground color of the second and third pickings than those of the first picking. Such later-coloring fruit was also softer for its color and usually of poorer quality. This delayed ground color development and lower quality is thought to be due to the effect of shade.

3. Fruit from "long-pruned" trees was more attractive and of better quality than that of the headed-back trees. Fruit from unpruned trees was highly colored and of good quality but lacked size, although thinned as severely as "long-pruned" trees.

4. Sugar content increased from 16 to 25 per cent from the greener lots of the first picking to the riper lots of the second picking, most of which was sucrose. The "long-pruned" lots showed the highest increase, the unpruned lots the lowest.

5. Fruit from "long-pruned" trees had 9 and 14 per cent more total sugar than headed-back and unpruned trees, respectively.

6. Fruit from headed-back trees was highest in total nitrogen, being 27.6 and 49.2 per cent higher than fruit from "long-pruned" and unpruned trees, respectively.

7. Elberta fruit of 12 to 18 pounds' pressure and of Color No. 3 (sulfur yellow) developed "fair" to "good" quality, with satisfactory condition in nearly all cases. Fruit which was harder or greener was generally unattractive and of poor quality. Fruit of Color No. 4 (amber yellow) and 10 to 14 pounds' pressure was generally satisfactory when precooled.

8. Elberta fruit from unpruned trees had a wider range of satisfactory pressure and color than fruit from other pruning treatments, lots ranging from 10 to 18 pounds and Colors Nos. 3 and 4 being satisfactory.

9. Fruit from headed-back trees was best picked at 12 to 16 pounds' pressure and Color No. 3 (sulfur yellow) ; No. 4 Color lots (amber yellow) were too mature.

10. Early Elberta fruit was best picked at Color No. 3 (sulfur yellow), with a pressure test of 16 to 18 pounds. Fruit of Color No. 4 and pressure test of 11 to 15 pounds was more attractive and of better quality but was too soft with ordinary handling. With precooling, however, when removed from storage fruit of this maturity was in satisfactory condition.

11. J. H. Hale peaches were best picked at Color No. 4 and with a pressure test of 12 to 15 pounds. Somewhat greener fruit developed only fair quality; riper fruit was satisfactory only when precooled. Hale peaches were safely picked at somewhat higher color than Elbertas.

12. Fruit growth measurements indicate that increase in size continues until the fruit becomes soft ripe. The rate of increase appears to diminish with advancing maturity. From the first to the third pickings Elberta peaches increased 13 per cent in diameter and 42.8 per cent in volume. Over the 4-week period of measurement the fruit increased 39 per cent in diameter and 125 per cent in volume.

[12]The color requirement for U. S. Fancy Grade is 25 per cent "good red color."

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RECOMMENDATIONS ON PEACH HARVESTING

1. Harvesting of peaches should be delayed as long as possible and still have the fruit arrive in firm condition, in order to improve its appearance, quality, size, and yield. Because of variations in carrying quality, in development of color and sugar content, and rate of softening under different conditions of weather, tree vigor, and exposure of the fruit to sunlight, no definite fixed pressure test and color recommendations can be made to fit all conditions.

2. The following suggestions in regard to harvesting for distant shipment are recommended **for trial** with **Elberta** peaches under **Utah** conditions:

(a) **Trees moderately or weakly vigorous, open, good exposure of fruit to sunlight, normal warm, sunny weather:** Delay picking until ripest fruit reaches Color No. 3 (sulfur yellow, Plate 1). Pick, in two pickings two or three days apart, all fruit reaching this color before it reaches the No. 4 color (amber yellow). Pick all later ripening fruits **regardless of color** when they reach 12 to 15 pounds' pressure test. Do not ship fruits testing less than 12 pounds unless precooled.

(b) **Trees dense-topped, highly vegetative (as with heavily headed-back trees, and in cold, rainy seasons:** Pick the ripest fruit when it tests 16 to 18 pounds with the pressure tester or reaches Color No. 3 (sulfur yellow). Fruit should be picked when it reaches 15 to 16 pounds' pressure **regardless of color.** Under these conditions, color standards should be set for pickers in each orchard as determined by the pressure tests. The colors used will generally lie between Color No. 2 (greenish yellow) and Color No. 3 (sulfur yellow).

3. **Early Elberta** peaches for distant shipment are safest picked slightly greener than is suggested for Elbertas.

4. **J. H. Hale** peaches because of their greater firmness and superior carrying quality may be harvested safely somewhat more mature than is suggested for Elbertas. Color No. 3 (sulfur yellow) is suggested for the minimum color, especially for densely vegetative trees, and Color No. 4 (amber yellow) for fruits well exposed to sunlight. Maximum softness suggested for shipping is 12 pounds, although highly-colored fruit of 8 to 12 pounds may be handled by precooling.

5. When market prices justify, it is suggested that picking be done at a somewhat riper stage than for ordinary handling, **together with precooling** to remove field heat promptly. This may be effected either by cooling in a refrigerated storage room before loading or by means of fans or salted ice (or both) after loading. Riper picking and precooling make possible improved color, attractiveness, sugar content, flavor, size, and yield.

6. Peaches for distant shipment or storage should be loaded promptly into iced cars or cold storage rooms to retard softening and decay.

7. Suggestion is also made that accurate pressure tests and color data (taken by reference to the standard color chart, Plate 1) be used by inspectors, buyers, and marketing agencies in describing fruit so that dealers can more accurately forecast its probable condition and quality on arrival.

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