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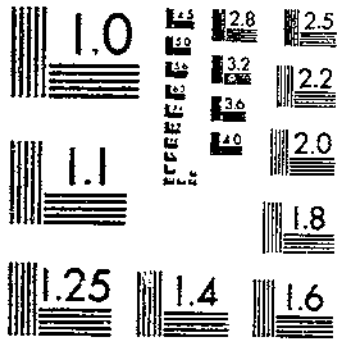
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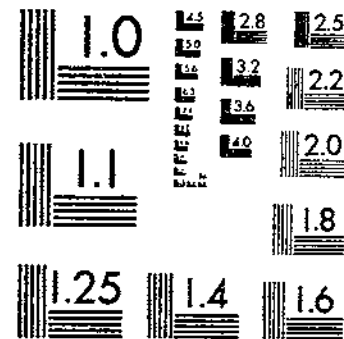
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1 OF 1

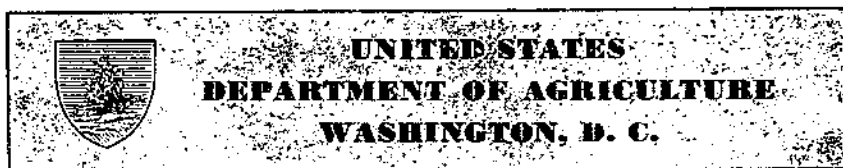
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# A Comparative Study of Storage at 32° and 36° F. of Apples Grown in the Potomac River Valley<sup>1</sup>

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## CONTENTS

DEPOSITORY

	Page		Page
Introduction .....	1	Presentation of results—Continued.	
Review of literature .....	2	Average results for all varieties .....	32
Material and methods .....	5	Development of decay in relation to storage	
Presentation of results .....	6	at 32° and 36° F. ....	33
Arkansas (Mammoth Black Twink) .....	6	Development of scald in relation to storage	
Ben Davis .....	8	at 32° and 36° F. ....	34
Bonum .....	9	Development of internal break-down in relation to storage at 32° and 36° F. ....	35
Delicious .....	11	Softening and ripening of apples at 32° and 36° F. ....	35
Golden Delicious .....	12	Development of ground color at 32° and 36° F. ....	37
Grimes Golden .....	15	Dessert quality of apples stored at 32° and 36° F. ....	37
Jonathan .....	17	Discussion .....	37
Rome Beauty .....	21	Summary and conclusions .....	39
Stayman Winesap .....	23	Literature cited .....	39
Wealthy .....	24		
Winesap .....	26		
Yellow Newtown (Albermarle Pippin) .....	28		
York Imperial .....	30		

## INTRODUCTION

Storage of apples at 32° F. has long been recognized as a standard procedure (29).<sup>2</sup> The United States Department of Agriculture, in a publication dealing principally with apple storage (16), has recommended 30° and 32° for the storage of apples except the Yellow Newtown variety grown in the Pajaro Valley of California for which a temperature of 35° to 38° is recommended. More recently the Department (31) has recommended storage at 31° to 32° with the above-named exception and the additional exception of Grimes Golden apples that are to be marketed early, in which cases storage at 35° to 38° should be used. Recently Plagge, Maney, and Pickett (27), of the Iowa Agricultural Experiment Station, have recommended storage at 35° and 36° for sound apples of proper maturity. This conflict of recommendations has reopened the question of the proper temperature for the storage of apples, and the investigations reported herein were undertaken to obtain further information as to which temperature level should be used.

<sup>1</sup> Received for publication August 27, 1940.

<sup>2</sup> Italic numbers in parentheses refer to Literature Cited, p. 39.

## REVIEW OF LITERATURE

Several low-temperature disorders of a physiological nature have been described which may be controlled or rendered less severe by storing the fruit at temperatures somewhat above 32° F. Perhaps the first to be studied (2, 18) was internal browning of the Yellow Newtown apple. This occurs particularly in the Pajaro Valley of California, and storage at 35° to 40° has been recommended for its control.

On the other hand, Brooks and Cooley (4) and Brooks, Cooley, and Fisher (5) found that Jonathan spot and scald developed more rapidly at relatively high temperatures and were considerably more severe at 41° F. than at 32°. These writers (5) also show that various fungus decays, such as alternaria rot (*Alternaria* sp.), anthracnose (*Neofabraea malicorticis* (A. B. Cordley) Jack.), black rot (*Sphaeropsis malorum* Pk.), and blue mold (*Penicillium expansum* Lk.) ex Thom., developed more rapidly at high temperature and caused larger decay spots at 41° than at 32°.

Plagge and Maney (23) confirmed the results of Brooks and Cooley (4) that Jonathan spot was more severe at higher temperatures (40° compared to 32° F.). They also found that Jonathan spot was increased by delay before storage.

Powell and Fulton (29) as early as 1903 found that scald appeared earlier on apples stored at 36° F. than on those stored at 32°. This was confirmed by Ramsey et al. (30). The results of Magness and Burroughs (15) showed that scald was frequently more severe at 32° than at 35°. They found soft scald to be greatly reduced by storage at 35° compared with 32°. They also found about twice as many decayed apples in lots stored at 35° as in lots at 32°. Softening of the apples was generally much more rapid at 35° than at 32° and the respiratory rate was about 50 percent greater at 35°. They reported a gradual loss in flavor and aroma during storage and, with long keeping, storage at 32° gave a somewhat higher quality product than that at 35°.

Plagge (20) confirmed the results of Magness and Burroughs that soft scald of Jonathan was more severe at 32° F. than at slightly higher temperatures (34°, 36°, and 40°) and reported also that soggy break-down of Grimes Golden responded to storage temperature in a manner similar to that of soft scald.

Magness et al. (16) have studied the rates of softening and respiration of a number of varieties of apples at various temperatures. They state that softening was about 25 percent more rapid at 32° F. than at 30°; at 40° it was slightly more than twice as fast as at 32°; and at 36° it was intermediate between that at 40° and that at 32°. There was a close agreement in the change in respiration and softening rates in relation to temperature.

A considerable increase in decay and bitter pit in Gravenstein apples at 36° F. as compared with 32° was indicated by data presented by Overholser (17). Scald was also increased by a higher temperature (45°) than 32°.

Kidd and West (12) describe internal break-down of some English-grown apples and report a low temperature type of break-down that was more severe at 32° F. than at slightly higher temperatures.

Additional results on the relation of temperature to soggy break-down of Grimes Golden and Wealthy apples have been reported by Plagge and Maney (24). They state that soggy break-down may be as severe in apples from other States (Washington and Michigan) as from Iowa, and that it was more severe at 30° F. than at 32°. It was greatly reduced at 34° and practically eliminated at 36°. They state that the apples became more yellow and attractive at 36° than at the lower temperatures and that the eating quality was decidedly improved by storage at 36°. Grimes Golden apples stored at 36° were only slightly softer at the end of the storage period than those stored at 32°. The increase in decay was only slight at 36° and scald was largely eliminated by the use of oiled paper. They state further that Grimes Golden held at the lower temperatures and then removed to a warm room appeared to become mealy just as soon as the fruit stored at 36°.

Golden Delicious has been reported by Plagge (21) to be very susceptible to soggy break-down, and as with Grimes Golden the trouble was more severe at 32° F. than at 36°. Storage of this variety at 36° is suggested.

The effect of storage at 32°, 35°, and 38° F. on New Zealand apples has been reported by Tiller and Clittenden (35). With five varieties internal break-down was less severe at 38° than at 35° and 32°. Bitter pit was less severe at 32° in the few varieties in which it occurred. Soft scald on Jonathan decreased with increased temperature. Better dessert quality was generally obtained at 35° and 32° than at 38°. For most of the varieties, storage at 35° or at 32° to 32° was recommended.

For Jonathan apples grown in Washington, Gerhardt and Ezell (11) recommended storage at 36° F. when the fruit is picked somewhat overmature or is delayed at room temperature before storage.

Brooks and Harley (6) have shown that soft scald and soggy break-down can be largely controlled by various prestorage treatments, among them exposure to carbon dioxide. This would serve as a basis for the control of these two diseases where it is desired to hold the fruit at 32° F.

Powell and Fulton (29, p. 21) state that—

the ripening processes are delayed more in a temperature of 31° to 32° F. than in 35° to 36°. The apple keeps longer in the lower temperature, it scalds less, the fruit rots and molds are retarded to a greater extent, while the quality, aroma, flavor, and other characteristics of the fruit are fully as good, and when removed from storage it remains in good condition for a longer period.

Kidd and West (18) have pointed out the importance of small differences in temperature in the development of wastage. Difference in temperature between 39° and 37° F. greatly influenced the percentage of wastage. In two seasons in which wastage was due to decay, it was greater at 39° than at 37°, whereas in one season in which low-temperature break-down was prevalent, the wastage was greater at the lower temperature.

In studies of scald on apples stored at 30°, 32°, 34°, 36°, and 40° F., Plagge, Maney, and Pickett (26) observed that scald increased with increase of temperature. As one of several means of controlling scald, they recommend storage at 36° to 35°, although their results indicate less scald at the lower temperatures of their tests.

In a report on break-down in Tasmanian apples, Carne and Martin (7) report that break-down was greater at 32° to 34° F. than at 38° to 40°.

Working with McIntosh and Fameuse apples, Davis and Blair (8, 9, 10) found that decay increased with higher temperatures (30°, 32°, 36°, and 40° F.). Scald was greater at 36° and 40° than at 30° and 32°. Core flush in Fameuse was also greater at 36° and 40° than at 30° and 32°, but in McIntosh it was less at the higher temperatures. Storage of McIntosh at the higher temperatures, however, was not recommended except in an atmosphere containing 7.5 percent of carbon dioxide. They observed (9) that scald was controlled by oiled wraps during storage, but that it developed on removal of the apples to warm temperatures despite the oiled paper.

Plagge, Maney, and Pickett (22, 27, 28) have discussed various functional diseases of the apple in storage. They show that the severity of scald and Jonathan spot is increased by increased storage temperatures and that soggy break-down (soft scale is considered to be one type of soggy break-down) is reduced by increased storage temperature. They state that storage results for 10 years showed that well-sprayed, carefully handled apples picked at correct maturity keep better at temperatures of 35° to 36° F. than at 31° to 32°. Apples so stored develop better flavor and color, are not susceptible to soggy break-down, and are much more valuable on the market. This conclusion was based on results with Grimes Golden, Jonathan, Golden Delicious, Northwestern Greening, Arkansas, Delicious, Ben Davis, Winesap, Willowtwig, and Stayman Winesap. They state that sound apples seldom become infected with rot-producing fungi and that scald is well controlled with oiled paper, and consequently there is little need to store at minimum temperatures to prevent these troubles when modern methods of spraying, harvesting, and packing are used.

Evidence that soggy break-down is more severe at 32° than at 36° F. is presented by Plagge and Maney (25) for the varieties Jonathan, Northwestern Greening, Wealthy, Winter Banana, and Golden Delicious.

With New Zealand apples, Sutherland (33, 34) has reported that internal break-down in Cox's Orange Pippin was less at 37° F. than at 34° and that soft scald in Jonathan was less at 36° than at 34°, with no difference in break-down and decay.

Working with Northwestern apples, Smith (32) reported that storage at 36° F. shortened the storage life of apples. Although the dessert quality of the apples might be better at the time of removal from storage it was usually poorer after a period at room temperature.

Brooks and McCulloch,<sup>3</sup> working with eastern-grown apples, confirmed the results of Brooks and Harley (6) that soft scald and soggy break-down tendencies in Grimes Golden and Jonathan may be inhibited by prestorage treatments with carbon dioxide and by waxing. They found that decay and internal break-down of Jonathan were approximately twice as great at 36° F. as at 32° and, with immediately stored lots, Jonathan spot was five times as serious at 36° as at 32°. They also found scald on Grimes Golden to be much more severe at 36°.

<sup>3</sup> Unpublished results.

The vitamin C content of apples has been found to decrease during storage, and the decrease is more rapid at 40° F. than at 32° (3).

The review of literature indicates agreement among investigators that certain physiological disorders, such as internal browning of the Yellow Newtown apples (2, 18), low-temperature break-down of certain English varieties (12), and soggy break-down and soft scald of Grimes Golden, Jonathan, and certain other varieties (15, 20, 21, 23, 24, 25, 27, 31) will be more severe at 30° to 32° F. than at 35° to 36° under conditions in which these disorders may be prevalent. On the other hand, certain other storage disorders, such as scald (4, 5, 10, 17, 26, 27, 29, 30), Jonathan spot (5, 23, 27), and decay (5, 10, 15, 17, 20), have been found to be more severe at the higher temperatures. The rates of ripening and softening (15, 16, 29) and of respiration (16) have been found to increase greatly with the temperature.

A distinction between mealy break-down due to old age and low temperature or soggy break-down has not always been made; the results reported indicate in some instances that break-down (presumably the mealy type) increased with temperature. Likewise, investigators are not agreed as to the effect of low-storage temperatures on the dessert quality of apples. Better quality at 36° F. is claimed for apples by the Iowa workers (24, 25, 27), whereas Powell and Fulton (29), Magness and Burroughs (15), Tiller and Chittenden (35), and Smith (32) report equally satisfactory or better quality at lower temperatures.

## MATERIAL AND METHODS

Apples of a number of commercial varieties were obtained during three seasons, 1935, 1936, and 1937, from commercial orchards within convenient distance of Washington, D. C. Results were obtained in 1934 also but for the Jonathan variety only. The fruit was obtained during the commercial harvest period at a time when it was considered to have reached proper picking maturity. The apples were taken immediately to the cold-storage plant of the United States Department of Agriculture at the Arlington Experiment Farm, Arlington, Va., and placed in storage the same day as picked, except that certain lots of the Jonathan variety were delayed at 65° or 70° F. for various periods previous to storage in order to make them more subject to soft scald. Generally 4 to 6 bushels of a variety were obtained and half of them were placed at 32° and the other half at 36°. One to two bushels were also placed at 70° for immediate ripening. At intervals of 1, 2, or 3 months, depending on the variety, 1 bushel was removed from each temperature and inspected. The lots were then placed at 70° and inspected again after 1 week at the higher temperature. It was intended that the inspections should come near the beginning, middle, and end of the main marketing season for each variety. After removal from storage the fruit should hold up long enough for marketing and for use by the consumer. Under commercial conditions the period between removal from storage and consumption no doubt varies greatly. In these investigations 1 week at 70° was used as representing a reasonable time for this purpose. It is considered that the condition of the fruit after a week at 70° is more important than the condition at the time of removal from storage.



The ground color and firmness and ripeness of the fruit were determined at the time of storage and at each inspection. At each inspection the amount of decay, break-down, scald, and other storage disorders was also determined and the dessert quality was estimated. The ground color was determined by comparison with a color chart (16) in which No. 1 represents a green color that corresponds to color K 6 on plate 20 in Maerz and Paul (14), No. 2 corresponds to K 4 on plate 19, No. 3 to color K 1 on plate 19; and No. 4 is yellow and corresponds nearly to color L 1 on plate 10. The firmness was determined by means of a pressure tester with a  $\frac{3}{16}$ -inch diameter plunger and a  $\frac{5}{16}$ -inch penetration of the pared surface. The ripeness of the fruit was estimated in accordance with the terms used and defined in the United States Standards for Apples. This was done by at least one of the writers and frequently by one or more of the marketing specialists of the Agricultural Marketing Service. The dessert quality of the fruit was judged by tasting a number of apples in a lot, and the ratings are based on the quality of the particular variety concerned. This is open to considerable personal error, but no more accurate means of evaluating dessert quality is available.

All temperatures referred to in this bulletin are of the Fahrenheit scale.

### PRESENTATION OF RESULTS

The results for each variety are presented separately in tables 1 to 13.

#### ARKANSAS (MAMMOTH BLACK TWIG)

The effect of storage at 32° and 36° F. on Arkansas apples is shown in table 1 for the three seasons covered by these investigations. The main market season for this variety, as given by Park and Pailthorp (19), extends from November to May. Considering all three seasons, the results do not indicate any consistent difference in the ground color of the fruit after storage at 32° and 36°. The apples were generally distinctly softer and riper at 36° than at 32°. The average pressure test of the lots stored at 32° for various periods was 15.9 pounds as compared with 14.2 pounds for comparable lots stored at 36°. Generally there was little or no decay found in these lots. The decay averaged slightly more at 36° than at 32°, but the difference does not appear to be significant.

Considerable water core was present in the apples when they were picked in 1935, and rather severe internal break-down developed during storage as a result of this; the decrease in water core during storage was apparently due largely to its development into break-down. The break-down noted in the crops of 1935 and 1936 was distinctly greater at 36°. Although the apples were packed with oiled paper, considerable scald developed after 4 to 5 months' storage. Generally somewhat more scald was found at 32° than at 36°. No difference in dessert quality was noted after 2 to 3 months' storage. With more extended storage, however, the apples held at 32° were generally of higher quality than those held at 36°.

APPLES IN THE POTOMAC RIVER VALLEY

TABLE 1.—Effect of storage at 32° and 36° F. on Arkansas (Mammoth Black Twig) apples

1935 CROP

Date of examination	Storage		After cleaning at 70° F.	Ground color No. 1	Pressure test	Ripeness <sup>2</sup>	Sound	Decay	Internal break-down	Scald <sup>3</sup>	Water core	Dessert quality <sup>4</sup>
	Temperature	Period										
<i>1936</i>												
Oct. 24.....	32	0	0	2.4	20.2	H	64.0	0.0	0.0	0.0	30.0	
Oct. 31.....	32	0	7	3.3	20.5	H	65.0	0.0	0.0	0.0	35.0	
Dec. 26.....	32	63	0	3.4	18.7	H	65.0	0.0	0.0	0.0	35.0	
	36	63	0	3.7	16.4	F	90.0	0.0	0.0	0.0	40.0	
<i>1936</i>												
Jan. 2.....	32	63	7	3.7	16.5	F	63.5	2.5	4.0	0.0	30.0	G
	36	63	7	3.8	14.3	FR	60.0	0.0	20.0	0.0	20.0	G
Feb. 27.....	32	126	0	3.8	14.7	F	100.0	0.0	0.0	0.0	0.0	
	36	126	0	4.0	13.7	FR	80.0	0.0	9.5	0.0	10.0	
Mar. 5.....	32	126	7	4.0	13.6	FR-R	72.0	1.5	19.0	7.5	0.0	
	36	126	7	4.0	13.7	R	45.0	0.0	51.0	4.0	0.0	
Apr. 24.....	32	183	0	4.0	13.6	FR-R	69.0	8.5	19.5	12.0	0.0	
	36	183	0	4.0	12.8	FR-R	57.5	4.0	26.5	12.0	0.0	P

1936 CROP

<i>1936</i>												
Nov. 13.....	(3)	0	0	2.1	22.1	H	100.0	0.0	0.0	0.0	0.0	
Nov. 20.....	(3)	0	7	1.9	19.7	F	100.0	0.0	0.0	0.0	0.0	
Dec. 14.....	32	31	0	1.8	19.9	H-F	100.0	0.0	0.0	0.0	0.0	
	36	31	0	1.7	16.8	F	100.0	0.0	0.0	0.0	0.0	
Dec. 21.....	32	31	7	2.9	15.9	FR-R	94.5	1.5	0.0	4.0	0.0	G
	36	31	7	2.8	14.1	R	95.0	1.5	0.0	3.5	0.0	G
<i>1937</i>												
Feb. 13.....	32	92	0	2.0	16.4	F	93.5	0.0	0.0	6.5	0.0	G
	36	92	0	2.4	13.9	FR	83.0	6.5	0.0	10.5	0.0	FG
Feb. 20.....	32	92	7	2.8	14.2	FR-R	63.5	0.0	1.5	35.0	0.0	G
	36	92	7	3.0	12.9	R	63.0	7.5	7.5	22.0	0.0	FG
Apr. 13.....	32	152	0	2.1	15.1	FR	55.0	1.0	0.0	44.0	0.0	G
	36	152	0	2.2	13.6	FR-R	62.5	2.5	2.0	33.0	0.0	FG
Apr. 20.....	32	152	7	3.0	14.7	FR	15.3	3.0	3.5	78.0	0.0	G
	36	152	7	2.9	11.9	R-OR	17.5	11.0	21.0	50.5	0.0	F

1937 CROP

<i>1937</i>												
Nov. 22.....	(2)	0	0	1.7	19.1	H	100.0	0.0	0.0	0.0	0.0	G
Nov. 29.....	(2)	0	7	1.9	18.0	H-F	100.0	0.0	0.0	0.0	0.0	
<i>1938</i>												
Jan. 24.....	32	63	0	2.2	18.3	H-F	100.0	0.0	0.0	0.0	0.0	G
	36	63	0	2.0	14.4	FR	100.0	0.0	0.0	0.0	0.0	G
Jan. 31.....	32	63	7	2.7	16.1	F-FR	100.0	0.0	0.0	0.0	0.0	FG
	36	63	7	2.3	14.1	FR-R	99.0	0.0	1.0	0.0	0.0	FG
Apr. 25.....	32	154	0	2.5	15.8	FR	87.0	1.0	0.0	12.0	0.0	G
	36	154	0	3.1	14.0	FR-R	81.5	5.0	0.0	13.5	0.0	G
May 2.....	32	154	7	2.9	14.0	FR-R	14.0	33.5	2.0	50.5	0.0	G
	36	154	7	3.6	15.5	FR-R	22.0	46.5	2.0	29.5	0.0	G-F

<sup>1</sup> Number on color chart, in which 1 represents green and 4 represents yellow.

<sup>2</sup> H=hard, F=firm, FR=firm ripe, R=ripe, OR=overripe. Italic letters indicate apples were mostly of that degree of ripeness.

<sup>3</sup> All lots packed in oiled paper.

<sup>4</sup> G=good, FG=fairly good, F=fair, P=poor.

<sup>5</sup> Not stored.

Storage of the 1935 crop at 32° F. was more satisfactory than at 36° because of the softer and riper condition of the fruit and the greater amount of internal break-down at 36°. Storage of the 1936 apples at either 32° or 36° was equally satisfactory for 1 month. For 3 or 5 months' storage, however, 32° was distinctly superior, as the apples stored at 36° developed more break-down and decay, were riper and softer, and had distinctly poorer dessert quality. Although more scald developed at 32° this was not considered as serious as the greater amount of decay and break-down at 36°. Storage of 1937 apples at either 32° or 36° was equally satisfactory for 2 months and even after 5 months there was no distinct superiority indicated for either temperature. When the apples were ripened at 70° after 5 months' storage those from 32° showed more scald and those from 36° more decay. The apples from 32° had somewhat better dessert quality. Considering all three seasons, storage at either 32° or 36° has sometimes given equally satisfactory results, particularly for short periods. However, when there has been a difference it has been in favor of the lower temperature. On the basis of these results, storage at 32° should be recommended for the Arkansas variety.

#### BEN DAVIS

The effect of storage at 32° and 36° F. on Ben Davis apples is shown in table 2 for the crops of 1935 and 1936. The market season for this variety extends from November to June (19). Although the fruit was picked considerably later in 1936 than in 1935, the ground color was not as yellow in 1936 as in 1935, nor did it become as yellow during storage. There was no indication that the apples became more yellow at 36° than at 32°. The apples stored at 36° were generally distinctly softer and riper than those stored at 32°. The firmness averaged 13.9 pounds in lots stored at 32° and 12.7 in those stored at 36°. Considerable decay developed in these lots of apples. In the 1935 crop there was no consistent difference between the amount of decay that developed after storage at the two temperatures, but in the 1936 crop the lots stored at 36° generally developed more decay than those stored at 32°. Very little internal break-down developed, with no significant difference between temperatures. These apples were not packed with oiled paper and in some instances considerable scald developed in late storage lots. In the 1935 crop, scald developed only after storage at 32°. In the 1936 crop the scald was less severe at 32° than at 36° on the February 16 inspection but more severe at 32° than 36° on the April 16 inspection. Somewhat superior flavor and dessert quality was generally noted in the apples from 32°, particularly after long storage.

For the 1935 fruit the softer and riper condition and the poorer dessert quality at 36° F. seem to indicate 32° as a more desirable storage temperature for this variety, at least for long periods (5 to 6 months) of storage. Although some scald developed at 32°, it is likely that this could have been controlled by the use of oiled paper. For 1936, fruit storage at 32° was distinctly superior to storage at 36°, as the fruit held at 36° was distinctly softer and riper, developed considerably more decay, and was of inferior dessert quality. On the basis of these results, therefore, 32° should be recommended as the storage temperature for the Ben Davis variety.

TABLE 2.—Effect of storage at 32° and 36° F. on Ben Davis apples  
1935 CROP

Date of examination	Storage		After ripening at 70° F.	Ground color No. <sup>1</sup>	Pressure test	Ripeness <sup>2</sup>	Sound	Decay	Internal break-down <sup>3</sup>		Seald <sup>4</sup>	Severe shrivel	Desert quality <sup>5</sup>
	Temperature	Period							Pct.	Pct.			
Oct. 9 1935	32	0	0	3.9	21.2	H	100.0	0.0	0.0	0.0	0.0		
Oct. 10	32	0	0	3.1	16.9	F	97.0	3.0	0.0	0.0	0.0		
Dec. 21	32	73	0	4.0	17.3	H-F	98.5	1.5	0.0	0.0	0.0		
	36	73	0	4.0	16.0	F	97.0	3.0	0.0	0.0	0.0		
Dec. 23	32	73	7	4.0	14.5	F-FR	95.0	5.0	0.0	0.0	0.0	G	G
	36	73	7	4.0	14.7	FR	93.0	8.0	2.0	0.0	0.0		
Mar. 10 1936	32	153	0	3.7	13.4	FR-R	91.5	8.5	0.0	0.0	0.0		
	36	153	0	4.0	11.0	R	95.5	3.0	0.0	0.0	1.5		
Mar. 17	32	153	7	4.0	12.3	R	56.0	21.0	0.0	21.5	1.5	G	G
	36	153	7	4.0	11.4	R	80.5	17.5	0.0	0.0	2.0		
Apr. 24	32	198	0	4.0	11.9	R	85.0	6.0	3.0	6.0	0.0		
	36	198	0	4.0	11.4	R	93.0	5.0	0.0	0.0	0.0		

1936 CROP

Oct. 27 1936	(3)	0	0	2.0	10.1	H-F	100.0	0.0	0.0	0.0	0.0		
Nov. 5	(4)	0	0	3.5	14.6	F-FR	87.0	13.0	0.0	0.0	0.0		
Dec. 9	32	43	0	2.6	18.1	H-F	93.0	7.0	0.0	0.0	0.0		G
	36	43	0	2.7	14.9	F	92.0	7.0	0.0	0.0	0.0		
Dec. 16	32	43	7	3.0	13.9	FR	87.0	13.0	0.0	0.0	0.0		G+
	36	43	7	3.5	13.3	FR	85.5	14.5	0.0	0.0	0.0		G
Feb. 9 1937	32	103	0	3.0	13.2	F-FR	92.0	8.0	0.0	0.0	0.0		FG
	36	103	0	3.3	11.7	FR-R	88.0	11.5	5.0	0.0	0.0		FG
Feb. 16	32	103	7	3.2	12.1	FR-R	75.0	14.0	2.0	9.0	0.0		FG
	36	103	7	3.2	11.2	FR-R	51.0	22.0	4.0	23.0	0.0		FG
Apr. 9	32	162	0	3.1	13.4	FR	91.0	9.0	0.0	0.0	0.0		F-P
	36	162	0	3.1	11.6	R	83.0	17.0	0.0	0.0	0.0		F
Apr. 16	32	162	7	3.5	12.5	FR	37.5	34.0	1.0	47.5	0.0		O-F
	36	162	7	3.0	11.8	R	37.5	34.0	0.0	28.5	0.0		F

<sup>1</sup> Number on color chart, in which 1 represents green and 4 represents yellow.

<sup>2</sup> H=hard, F=firm, FR=firm ripe, R=ripe.

<sup>3</sup> Not packed in oiled paper.

<sup>4</sup> G=good, FG=fairly good, F=fair, P=poor.

<sup>5</sup> Not stored.

BONUM

The effect of storage at 32° and 36° F. on Bonum apples is shown in table 3. In 1935 the apples were obtained from an orchard near Falls Church, Va., at a relatively low altitude, whereas in 1936 and 1937 the apples were obtained from an orchard at a much higher altitude near Linden, Va. The apples were much firmer at harvest in the latter two seasons than in the first.

The 1935 and 1936 fruit was generally distinctly more yellow and riper after storage at 36° than after 32° F. storage. There was no marked or consistent difference in ripeness or ground color of the 1937 fruit. Appreciable amounts of decay occurred only in the 1935 apples and at the time the fruit was removed from the storage temperatures there was no significant difference in the amount of decay. However, after the fruit was ripened at 70°, the decay was considerably more severe in the lots from 36° storage in the 1935 season. In two instances at least 5 percent break-down occurred, and in both instances it was in fruit that had been stored at 36°. Severe scald occurred with the 1936 crop, although the apples were packed in oiled paper. In 1935

and 1937 scald was present only at the final inspection when the apples were ripened after 4 months' storage, and it was more severe in the apples from 32° storage. In the 1936 crop, on the contrary, scald was more severe in apples from 36° storage except at the final inspection when no difference was found. There was a tendency for this variety to shrivel, and this was more severe at 32°, probably because of the somewhat lower humidity in the room held at this temperature. Little or no difference in dessert quality was noted between apples from the two temperatures.

TABLE 3.—Effect of storage at 32° and 36° F. on Bonum apples  
1935 CROP

Date of examination	Storage		After ripening at 70° F.	Ground color No. 1	Pressure test	Ripeness <sup>2</sup>	Sound	Decay	Internal break down	Scald <sup>3</sup>	Severe shrivel	Dessert quality <sup>4</sup>
	Temperature	Period										
1935												
Sept. 9	32	0	0	1.7	19.4	H	100.0	0.0	0.0	0.0	0.0	-----
Sept. 16	32	0	7	2.6	13.4	FR-R	100.0	.0	.0	.0	.0	-----
Nov. 12	32	64	0	2.4	15.2	H-F	98.5	1.5	.0	.0	.0	G
Nov. 19	36	64	0	2.6	14.7	F	99.5	.5	.0	.0	.0	G
	32	64	7	2.7	13.1	FR	90.0	9.5	.5	.0	.0	F
	36	64	7	3.9	13.0	R-OR	80.0	18.0	2.0	.0	.0	P
1936												
Jan. 9	32	122	0	3.2	14.1	FR	70.5	13.0	.0	.0	7.5	-----
	36	122	0	3.6	12.3	FR-R	81.0	10.0	.5	.0	5.5	-----
Jan. 16	32	122	7	3.3	13.1	FR-R	39.5	14.5	1.0	46.0	.0	-----
	36	122	7	4.0	10.5	R	46.0	33.5	5.0	15.5	.0	-----

1936 CROP

1936												
Sept. 9	(3)	0	0	1.3	26.0	H	100.0	0.0	0.0	0.0	0.0	-----
Sept. 16	(3)	0	7	2.6	20.2	F	100.0	.0	.0	.0	.0	-----
Nov. 9	32	61	0	2.0	16.3	F	100.0	.0	.0	.0	.0	G
Nov. 16	36	61	0	2.3	15.4	F-R	100.0	.0	.0	.0	.0	G
	32	61	7	2.9	12.1	FR	94.0	1.0	.0	.0	.0	G
	36	61	7	2.8	10.5	FR-R	73.5	.5	.0	26.0	.0	FG
1937												
Feb. 3	32	147	0	2.2	13.1	FR-R	88.0	.0	.0	.0	12.0	G
	36	147	0	2.6	13.1	FR-R	76.0	1.5	.0	21.5	1.0	FG
Feb. 10	32	147	7	2.6	11.9	FR-R	10.0	1.0	.0	59.0	.0	G
	36	117	7	3.5	11.7	FR-R	3.0	.5	.5	96.0	.0	G
Mar. 8	32	180	0	2.4	13.7	FR-R	65.5	.5	.0	5.5	28.5	G-F
	36	180	0	2.9	12.7	R	64.5	1.0	.0	29.0	5.5	F
Mar. 15	32	180	7	---	11.7	FR-R	11.0	1.5	1.5	86.0	.0	FG
	36	180	7	---	12.7	FR-R	1.0	6.0	7.0	86.0	.0	F

1937 CROP

1937												
Sept. 16	(3)	0	0	1.2	27.5	H	100.0	0.0	0.0	0.0	0.0	-----
Sept. 21	(3)	0	6	2.2	20.0	H-F	100.0	.0	.0	.0	.0	-----
Nov. 16	32	61	0	1.4	17.4	F-F	99.5	.3	.0	.0	.0	G
Nov. 23	36	61	0	1.7	13.5	FR-R	93.5	.5	.0	.0	.0	G+
	32	61	7	2.6	12.5	FR	63.5	1.0	.0	.0	.0	G-F
	36	61	7	3.0	13.4	FR	68.5	1.0	.0	.0	.5	-----
1938												
Jan. 17	32	123	0	2.3	15.1	FR	100.0	.0	.0	.0	.0	G-F
	36	123	0	2.4	13.5	FR	93.5	.0	.0	.0	.5	G
Jan. 21	32	123	7	2.5	13.1	FR-R	66.5	.0	1.5	32.0	.0	G
	36	123	7	3.0	12.8	FR-R	74.0	.5	.5	25.0	.0	G

<sup>1</sup> Number on color chart, in which 1 represents green and 4 represents yellow.  
<sup>2</sup> H=hard, F=firm, FR=firm ripe, R=ripe, OR=overripe. Italic letters indicate apples were mostly of that degree of ripeness.  
<sup>3</sup> Apples packed in oiled paper in 1936 and 1937 but not in 1935.  
<sup>4</sup> G=good, FG=fairly good, F=fair, P=poor.  
<sup>5</sup> Not stored.

Storage at 32° F. seemed preferable in 1935 because of the greater amount of decay that developed during ripening after storage at 36°. Although more scald developed during ripening after storage at 32°, this was not as serious as the decay and might have been controlled with oiled paper. In the 1936 season, 32° storage was again preferable because of the greater amount of scald that developed at 36°. In the 1937 season there was practically no difference between the fruit from the two temperatures, and either 32° or 36° was satisfactory. On the basis of these results for all three seasons, 32° storage should be recommended for the Bonum variety, as this temperature was somewhat preferable during two seasons and equally satisfactory in the other.

### DELICIOUS

The effect of storage temperature on crops of Delicious apples for the three seasons is shown in table 4. The main market season for this variety extends from October to April (19). The ground color at harvest was about 2.5 in all three seasons and changed gradually during storage to 4 or deeper with no appreciable difference between storage at 32° and at 36° F. The apples were generally distinctly softer and riper after storage at 36° than after storage at 32°, and the firmness averaged 11.6 pounds at 36° and 12.9 pounds for comparable lots at 32°. Relatively little decay or break-down developed in these apples, and there was no significant difference in the amount of decay at the two temperatures in any of the seasons. In the 1935 and 1937 crops more scald developed at 32° than at 36°. Although the fruit was packed with oiled paper in 1936, rather severe scald developed. This was more severe at 36° at the earlier inspection, but at the time of the final inspection it was more severe at 32°. The dessert quality of this variety depended greatly upon the ripeness of the apples at the time they were sampled. Thus, after 2 months' storage in 1936, the apples from 36° were in prime eating condition and were more aromatic than those from 32° that had not yet ripened to prime eating condition. However, after 8 days at 70° the apples from 36° were past their prime and had less flavor than those from 32°, which were now prime. In general, there was no appreciable difference between the dessert quality of apples of the 1935 crop stored at 32° and those at 36°. The apples of the 1936 crop were generally considered better after storage at 32°, whereas those of the 1937 crop gave better results at 36°.

For the 1935 crop there was very little choice between the two temperatures with slight preference for 36°, particularly with storage of about 4 months or less because of the greater percentage of decay and scald at 32° when ripened after 4 months. However, the scald was not severe and probably could have been controlled with oiled paper. For the 1936 crop, storage at 32° was more satisfactory because of the firmer condition of the fruit from this temperature and the consistently better dessert quality. There were rather large but not consistent differences in the amount of decay, break-down, or scald that developed. For the 1937 crop, storage at 36° seemed somewhat more satisfactory, as the dessert quality was better at this temperature, and considerable scald developed when ripened after 4 months at 32°. Although the apples were riper at 36°, they did not become undesirably so during the storage season. These results

indicate that either temperature of storage might be used with the Delicious variety, there being a slight preference for 36° for short storage.

TABLE 4.—Effect of storage at 32° and 36° F. on Delicious apples

1935 CROP

Date of examination	Storage		After ripening at 70° F.	Ground color No. 1	Pressure test	Ripeness 2	Sound	Density	Internal break-down	Scald 3	Severe shrivel	Desert quality
	Temperature	Period										
Sept. 27, 1935	32	0	0	2.7	18.0	H	100.0	0.0	0.0	0.0	0.0	-----
Oct. 5	32	0	8	3.0	15.6	F-FR	100.0	0.0	0.0	0.0	0.0	VG
Dec. 4	32	68	0	3.7	17.0	II-F	100.0	0.0	0.0	0.0	0.0	VG
	36	68	0	3.9	15.5	F-FR	100.0	0.0	0.0	0.0	0.0	VG
Dec. 11	32	68	7	3.8	13.2	F-FR	99.0	1.0	0.0	0.0	0.0	VG
	36	68	7	3.9	13.8	FR	99.0	1.0	0.0	0.0	0.0	VG-G
1936												
Feb. 11	32	137	0	3.9	14.4	F	98.0	2.0	0.0	0.0	0.0	VG
	36	137	0	4.0	13.7	FR	100.0	0.0	0.0	0.0	0.0	VG
Feb. 18	32	137	7	4.0	11.0	FR	94.0	5.0	0.0	8.0	0.0	G
	36	137	7	4.0	11.0	FR	99.0	0.0	0.0	1.0	0.0	G
Apr. 13	32	190	0	4.0	12.3	FR-R	87.0	2.0	0.0	8.5	2.5	FG
	36	199	0	4.0	12.3	FR-R	95.5	3.5	0.0	0.0	0.0	FG

1936 CROP

Sept. 21, 1936	(5)	0	0	2.7	15.6	F-FR	100.0	0.0	0.0	0.0	0.0	-----
Sept. 28	(5)	0	7	3.5	11.4	FR	100.0	0.0	0.0	0.0	0.0	G
Nov. 19	32	59	0	3.5	13.8	F-FR	99.0	1.0	0.0	0.0	0.0	G
	36	59	0	3.8	10.7	FR-R	100.0	0.0	0.0	0.0	0.0	G-VG
Nov. 27	32	59	8	3.9	9.2	FR-R	95.0	1.0	0.0	1.0	0.0	G-VG
	36	59	8	4.0	8.6	R	90.0	1.0	0.0	0.0	0.0	G
1937												
Feb. 5	32	137	0	3.7	12.4	F-FR	98.5	1.5	0.0	0.0	0.0	VG
	36	137	0	3.6	9.8	FR-R	91.5	1.0	0.0	7.5	0.0	G-VG
Feb. 12	32	137	7	4.0	10.5	FR-R	29.0	2.5	2.0	66.5	0.0	G
	36	137	7	3.8	8.7	R-OR	28.5	1.0	1.0	69.5	0.0	G-F
Mar. 22	32	182	0	3.5	11.1	FR	86.0	1.5	0.0	12.5	0.0	VG
	36	182	0	3.7	9.9	FR-R	63.0	1.5	1.0	34.5	0.0	FG
Mar. 20	32	182	7	3.9	10.4	H	5.5	1.5	1.0	92.0	0.0	FG
	36	182	7	3.7	9.2	R-OR	13.0	5.5	5.0	76.5	0.0	F

1937 CROP

Sept. 21, 1937	(5)	0	0	2.4	17.8	H	100.0	0.0	0.0	0.0	0.0	-----
Sept. 28	(5)	0	7	2.5	12.9	F-FR	100.0	0.0	0.0	0.0	0.0	-----
Nov. 22	32	62	0	3.2	10.5	F	100.0	0.0	0.0	0.0	0.0	-----
	36	62	0	3.1	14.6	F-FR	100.0	0.0	0.0	0.0	0.0	FG
Nov. 20	32	62	7	3.4	12.5	F-FR	93.0	1.0	0.0	0.0	0.0	FG
	36	62	7	3.7	12.2	FR-R	100.0	0.0	0.0	0.0	0.0	FG-G
1938												
Jan. 20	32	121	0	3.3	15.3	F	90.0	0.0	0.0	1.0	0.0	F-P
	36	121	0	3.4	12.8	F-FR	100.0	0.0	0.0	0.0	0.0	F
Jan. 27	32	121	7	3.3	12.4	FR	48.0	1.0	0.0	51.0	0.0	F
	36	121	7	3.6	11.5	FR-R	97.5	1.0	1.5	0.0	0.0	G

1 Number on color chart, in which 1 represents green and 4 represents yellow.  
 2 H=hard, F=firm, FR=firm ripe, R=ripe, OR=overripe. Italic letters indicate apples were mostly of that degree of ripeness.  
 3 Packed in oiled paper in 1936 and 1937 seasons but not in 1935 season.  
 4 VG=very good, G=good, FG=fairly good, F=fair, P=poor.  
 5 Not stored.

## GOLDEN DELICIOUS

The effect of storage temperatures of 32° and 36° F. on Golden Delicious apples is shown in table 5. Somewhat deeper yellow developed on the apples at 36° in the 1936 season. In the other two seasons, however, there was no appreciable difference between the two temperatures. The apples were distinctly softer and riper at 36° than at 32° during two of the seasons, but there was no apparent difference in the 1935 crop. Appreciable amounts of decay developed in the 1935 crop only, and it was more severe at 32° than at 36°. Scald developed on the apples of the 1936 crop only and was most severe at 36°. Golden Delicious apples are rather subject to shriveling during storage, and appreciable shriveling occurred in the 1935 and the 1936 crops. This was most severe both of these seasons at 32°. With the same relative humidity the vapor-pressure deficit would be greater at the higher temperature (36°) and more transpiration and shriveling therefore would be expected. However, at the lower temperature (32°) there is a greater tendency for the moisture to freeze out of the air and consequently a lower relative humidity would be maintained.

An examination of the hygrothermograph charts for the period of September 16, 1936, to January 10, 1937, showed that the humidity at both temperatures varied between 80 and 90 percent but that at 36° it generally ran above 85 percent and at 32° below 85 percent. The approximate average humidity for this period was determined by averaging the humidity at noon of the 1st, 5th, 10th, 15th, 20th, 25th, and 30th of each month. The average thus obtained was 83.6 percent for 32° and 87.5 percent for 36°. Thus the greater shriveling at 32° was due to the lower humidity at this temperature and only indirectly to temperature. Differences in dessert quality due to storage temperature were not generally apparent. However, in some instances in 1936 and in 1937 the apples from 32° storage were found to be of better quality than those from 36°.

In the 1935 season storage at 36° F. was more satisfactory for this variety, as there was generally a higher percentage of sound fruit at this temperature after 4 or more months' storage and there was no apparent difference between fruit stored at this temperature and that stored at 32° in firmness or dessert quality. For short storage (2 months) 32° and 36° were equally satisfactory. In the 1936 crop the apples stored at 36° were distinctly softer and riper than those stored at 32°, and after 4 months apples stored at 36° developed considerable scald when ripened at 70°. The 1936 results, therefore, indicated 32° for the storage of this variety. Practically no storage disorders occurred with the 1937 crop. At 36° the apples were softer and riper and of somewhat poorer dessert quality. The 1937 results, therefore, also indicated 32° storage. Thus in two of the three seasons studied, 32° was found to be superior to 36° for the storage of Golden Delicious apples.



14 TECHNICAL BULLETIN 776, U. S. DEPT. OF AGRICULTURE

TABLE 5.—Effect of storage at 32° and 36° F. on Golden Delicious apples

1935 CROP

Date of examination	Storage		After ripening at 70° F.	Ground color No. 1	Pressure test	Ripeness 2	Sound	Decay	Internal break-down 3	Scald 4	Severe shrivel	Dessert quality 5
	Temperature	Period										
<i>1935</i>												
Oct. 9.....	(4) 32	0	0	3.6	16.2	H-F	100.0	0.0	0.0	0.0	0.0	G
Oct. 18.....	(5) 32	0	7	4.0	12.5	F-FR	100.0	.0	.0	.0	.0	VG
Dec. 16.....	32	68	0	4.0	13.7	F	100.0	.0	.0	.0	.0	VG-G
	36	68	0	4.0	13.7	F-FR	98.5	1.5	.0	.0	.0	VG
Dec. 23.....	32	68	7	4.0	12.2	FR	100.0	.0	.0	.0	.0	VG
	36	68	7	4.0	12.3	FR	96.5	3.5	.0	.0	.0	VG
<i>1936</i>												
Feb. 18.....	32	132	0	4.0	11.4	FR	95.0	4.0	.0	.0	1.0	VG
	36	132	0	4.0	11.4	FR	97.5	1.5	.0	.0	1.0	VG
Feb. 25.....	32	132	7	4.0	10.1	FR-R	81.5	14.5	.0	.0	4.0	VG
	36	132	7	4.0	10.6	FR-R	91.5	5.0	.0	.0	8.5	VG
Apr. 14.....	32	188	0	4.0	11.8	FR-R	71.0	18.0	.0	.0	11.0	
	36	188	0	4.0	11.5	FR-R	92.5	4.5	.0	.0	3.0	
Apr. 21.....	32	188	7	4.0	10.6	FR-R	54.0	35.0	.0	.0	11.0	G
	36	188	7	4.0	10.8	FR-R	80.5	16.5	.0	.0	3.0	

1936 CROP

<i>1936</i>												
Sept. 26.....	(5) 32	0	0	2.3	15.5	H-F	100.0	0.0	0.0	0.0	0.0	G
Oct. 6.....	(5) 32	0	10	2.8	13.6	F	100.0	.0	.0	.0	.0	G
Nov. 16.....	32	51	0	2.5	13.9	FR	100.0	.0	.0	.0	.0	FG
	36	51	0	2.0	11.5	FR-R	100.0	.0	.0	.0	.0	FG
Nov. 23.....	32	51	7	3.3	10.2	FR-R	100.0	.0	.0	.0	.0	G
	36	51	7	3.5	10.0	R	100.0	.0	.0	.6	.0	FG
<i>1937</i>												
Feb. 4.....	32	131	0	3.0	9.7	R	97.5	.5	.0	.0	2.0	F
	36	131	0	3.8	8.8	R+	99.5	.5	.0	.0	.0	F
Feb. 11.....	32	131	7	3.0	10.6	FR-R	97.0	1.0	.0	.0	2.0	F
	36	131	7	3.6	8.8	R	5.5	2.0	.5	37.5	.6	P
Mar. 16.....	32	171	0	3.3	10.2	R	91.0	.5	.0	.0	8.5	FG
	36	171	0	3.8	9.6	R+	94.0	.0	.0	5.0	1.0	FG
Mar. 23.....	32	171	7	3.7	9.0	R	82.6	3.5	.0	3.0	11.0	F-P
	36	171	7	3.8	8.4	R+	14.0	3.5	1.5	80.9	1.0	P

1937 CROP

<i>1937</i>												
Sept. 22.....	(5) 32	0	0	1.9	16.9	H-F	100.0	0.0	0.0	0.0	0.0	
Oct. 1.....	(4) 32	0	9	3.6	12.6	FR	100.0	.0	.0	.0	.0	G
Nov. 23.....	32	62	0	2.5	13.4	F-FR	100.0	.0	.0	.0	.0	G-F
	36	62	0	2.8	11.1	FR-R	100.0	.0	.0	.0	.0	G-F
Nov. 30.....	32	62	7	3.3	11.1	FR	99.0	1.0	.0	.0	.0	G-P
	36	62	7	3.3	10.1	FR-R	100.0	.0	.0	.0	.0	G-P
<i>1938</i>												
Jan. 20.....	32	120	0	2.9	11.4	FR	99.5	.5	.0	.0	.0	P
	36	120	0	3.0	9.9	FR-R	99.5	.5	.0	.0	.0	P
Jan. 27.....	32	120	7	3.8	10.7	FR-R	99.5	.5	.0	.0	.0	F
	36	120	7	3.6	9.6	R	95.5	4.5	.0	.0	.0	F-P

1 Number on color chart, in which 1 represents green and 4 represents yellow.

2 H=hard, F=firm, FR=firm ripe, R=ripe. Italic letters indicate apples were mostly of that degree of ripeness.

3 Packed in oiled paper.

4 VG=very good, G=good, FG=fairly good, F=fair, and P=poor.

5 Not stored.

## GRIMES GOLDEN

The effect of storage at 32° and at 36° F. on Grimes Golden apples is shown in table 6. The market season for this variety extends from September to January (19). There was generally a tendency for the ground color to become somewhat more yellow during storage at 36° than at 32° in the 1936 and 1937 crops, but not in the 1935 crop. The data do not indicate any marked difference in firmness or ripeness during storage at the two temperatures. During the three seasons there was no consistent difference in the amount of decay that developed at the two temperatures. Likewise, internal break-down was not consistently higher at either of the temperatures. A high percentage of the 1935 and 1936 fruit developed scald when no oiled paper was used, and even the 1937 fruit packed in shredded oiled paper developed considerable scald. The scald did not develop on the 1937 apples while they were in cold storage, but became apparent after they were removed to the 70° ripening room. It was more severe in the fruit from 32° storage. In the other seasons, scald developed in cold storage, and there was no consistent difference between the two temperatures in the amount of scald induced. For 1936 fruit, storage at 32° resulted in somewhat better dessert quality in the apples than did storage at 36°. In the other two seasons no difference in dessert quality was noted.

With the 1935 crop the results indicate that either 32° or 36° F. would have been satisfactory for 2 months' storage, as there was no appreciable difference in the fruit, and it is likely that the scald could have been greatly reduced by the use of oiled paper. After 4 months' storage, neither temperature was satisfactory, principally because of scald. In 1936 storage at 36° for 2 months gave better results than 32° primarily because of the greater scald development at 32°. After 4½ months, however, 32° was superior because of the much greater amount of scald at 36° at the time the fruit was removed from storage and because of the better flavor and less ripe condition of the fruit from 32° storage. During ripening at 70°, excessive scald developed on the apples from both storage temperatures. After 6 months' storage, 32° was again superior because of the better dessert quality and slightly less decay at this temperature. Excessive scald developed at both temperatures, but no oiled paper had been used in the packages. With the 1937 crop 36° storage was distinctly superior both for 2 and for 4 months, as considerably more scald developed at 32°. The apples also developed more break-down at 32° when ripened after 4 months' storage.

On the basis of these results for the three seasons, storage at 36° F. is recommended for Grimes Golden apples, particularly for relatively short storage of 2 months or less.

TABLE 6.—Effect of storage at 32° and 36° F. on Grimes Golden apples

1935 CROP

Date of examination	Storage		After ripening at 70° F.	Ground color No. 1		Ripeness 2	Sound	Decay	Internal break-down 3	Said 4	Dessert quality 5
	Temperature	Period		Days	Lb.						
<i>1935</i>											
Sept. 18	32	73	0	3.1	14.9	F-FR	109.0	0.0	0.0	0.0	
Sept. 25	32	73	7	3.2	16.4	F	99.0	0.0	0.0	0.0	
Nov. 30	36	73	0	3.2	16.3	F	99.5	1.0	0.0	0.0	
Dec. 7	32	73	7	4.0	14.0	FR	39.5	5.0	0.0	51.3	VG
	36	73	7	4.0	14.4	FR	43.0	4.0	1.5	51.3	VG
<i>1935</i>											
Jan. 30	32	134	0	3.8	13.7	FR	88.0	3.5	0.0	8.5	VG
	36	134	0	3.9	12.9	FR	68.0	5.0	2.0	25.5	VG
Feb. 6	32	134	7	4.0	10.0	R	0.0	15.0	5.0	100.0	
	36	134	7	4.0	11.0	R	0.0	44.0	44.0	100.0	

1936 CROP

<i>1936</i>											
Sept. 15	32	62	0	1.2	23.0	H	100.0	0.0	0.0	0.0	
Sept. 25	32	62	10	2.7	15.4	F-FR	100.0	0.0	0.0	0.0	G
Nov. 16	36	62	0	1.5	15.4	F-FR	100.0	0.0	0.0	0.0	G
	32	62	0	2.0	15.0	FR	100.0	0.0	0.0	0.0	G
Nov. 23	32	62	7	3.2	12.4	FR-R	16.0	1.5	1.8	82.5	G+
	36	62	7	3.6	11.7	FR-R	38.5	0.0	0.0	61.5	G
<i>1937</i>											
Feb. 4	32	142	0	2.0	12.3	FR	100.0	0.0	0.0	0.0	G
	36	142	0	2.9	12.5	R	20.0	1.0	0.0	79.0	F
Feb. 11	32	142	7	3.3	12.3	FR-R	0.0	4.0	1.0	95.0	F-G
	36	142	7	3.3	12.5	FR-R	0.0	5.0	5.0	90.0	F-G
Mar. 15	32	181	0	12.5		FR-R	17.0	0.0	0.0	83.0	G
	36	181	0	12.5		FR-R	4.0	5.5	0.0	90.5	F
Mar. 22	32	181	7	12.0		R-OR	0.0	10.0	8.0	82.0	F
	36	181	7	11.6		R-OR	0.0	15.5	3.0	76.5	F

1937 CROP

<i>1937</i>											
Sept. 14	32	62	0	1.6	21.9	H	100.0	0.0	0.0	0.0	
Sept. 21	32	62	7	2.1	19.3	H-F	100.0	0.0	0.0	0.0	
Nov. 15	32	62	0	1.9	16.3	F-FR	100.0	0.0	0.0	0.0	G-VG
	36	62	0	2.3	13.5	F-FR	100.0	0.0	0.0	0.0	G-VG
Nov. 22	32	62	7	3.2	14.6	FR	61.0	3.5	2.5	33.0	G
	36	62	7	3.7	13.5	FR	98.5	0.0	1.5	0.0	G
<i>1938</i>											
Jan. 14	32	122	0	2.1	14.3	FR-R	90.0	0.0	1.0	0.0	G
	36	122	0	2.9	14.9	FR-R	100.0	0.0	0.0	0.0	G
Jan. 21	32	122	7	3.8	13.4	FR and OR	3.5	1.5	22.0	74.0	G-F
	36	122	7	3.8	12.9	FR-R-OR	47.0	1.5	10.0	41.5	G-F

1 Number on color chart, in which 1 represents green and 4 represents yellow.  
 2 H=hard, F=firm, FR=firm ripe, R=ripe, OR=overripe. Italic letters indicate apples were mostly of that degree of ripeness.

3 Packed with oiled paper in 1937 but not in 1935 or 1936.

4 VG=very good, G=good, FG=fairly good, F=fair, P=poor.

5 Not stored.

6 Also scalded.

## JONATHAN

The effect of storage at 32° and 36° F. on Jonathan apples is shown in table 7 for four seasons. This variety is particularly susceptible to soft scald, which is generally more severe in apples that have been held at high temperatures (50°-70° or higher) for several days before storage (5) and which has been found to be more severe at 32° than at 36°. The studies with this variety in 1934 and 1935 were concerned to a large extent with an investigation of this storage disorder, and certain lots were held at 65° and 70° for a delay of 3 to 10 days before storage. Pickings in 1934 and 1935 were made at different stages of maturity. In 1934, susceptibility to soft scald was increased by delay at room temperature of fruit picked on September 11 but was decreased in the case of fruit picked later (September 19). Likewise in 1935, soft scald was increased by delay in the pickings made on September 6 and 19, but not in the later picking of September 30. Considerable soft scald developed in some lots of the 1934 and 1935 pickings. As reported by others (5, 27), soft scald was much less severe at 36°. In 1934 a superficial browning of the skin was observed. This was generally confined to small spots a quarter to a half inch in diameter and was not typical of either soft scald or superficial scald. It was designated "bruise scald," as the lesions were slightly depressed and sometimes seemed to have been caused by bruising or rubbing. This type of scald developed at both 32° and 36°, with no consistent difference between the two temperatures. Jonathan apples are very susceptible to Jonathan spot. This disorder is aggravated by late picking and by exposure to high temperatures during storage. Thus delay at high temperature previous to storage is likely to increase the amount of both soft scald and Jonathan spot in storage, which fact makes prompt storage of this variety doubly important. Although storage at 36° greatly reduces the percentage of soft scald, it tends to increase the percentage of Jonathan spot.

There were no consistent differences between the two storage temperatures in the amount of decay or of break-down that developed. The greater percentage of soft scald that developed at 32° F. was counterbalanced by the greater percentage of Jonathan spot at 36°. Consequently there was no consistent difference between the percentages of sound fruit present in the lots from the two temperatures. For all four seasons, the difference between the mean percentages of sound apples from the two temperatures in 44 comparable lots was only 1.3 in favor of 32° storage. This is obviously not a significant difference. Jonathan apples stored at 36° were generally distinctly softer and riper than the comparable lots held at 32°. When a difference in dessert quality was noted, this was also in favor of 32°. As a further indication of their greater ripeness, the apples generally became slightly more yellow at 36° than at 32°. This difference in ground color was not sufficient to materially affect their salability.

TABLE 7.—Effect of storage at 32° and 36° F. on Jonathan apples<sup>1</sup>

1934 CROP

Date of examination	Pick No.	Storage		After ripening at 70° F.	Ground color No.†	Pressure test Lb.	Ripeness ‡	Sound Pct.	Decay Pct.	Internal break-down Pct.	Scald †		Jonathan spot Pct.	Desert quality †
		Tempera- ture	Period								Soft Pct.	Bruise Pct.		
		° F.	Days											
1934														
Sept. 11	1	(9)	0	0		15.7		100.0	0.0	0.0	0.0	0.0	0.0	
	1	32	63	0		12.6		81.0	2.0	.0	.5	0.0	10.5	
Nov. 13	1	36	63	0		11.1		93.5	3.0	.0	.0	2.5	1.0	
	1	32	57	0		11.1		87.5	1.0	.0	6.5	4.0	1.0	
Nov. 13 †	1	36	57	0		10.8		86.0	2.5	.0	1.0	7.0	3.5	
	1	32	53	0		10.5		74.5	1.0	.0	11.5	4.0	9.0	
Nov. 13 ‡	1	36	53	0		10.7		74.5	1.5	.0	6.0	3.5	14.5	
	1	32	66	0				97.5	.0	.0	.0	1.5	1.0	
Dec. 10	1	36	66	0				94.0	.0	.0	.0	2.5	3.5	
	1	32	84	0				69.5	.5	.0	26.0	4.5	16.0	
Dec. 10 †	1	36	84	0				73.5	.5	.0	4.5	5.5	16.0	
	1	32	80	0				69.5	.5	.0	14.0	4.0	12.0	
Dec. 10 ‡	1	36	80	0				77.0	.0	.0	10.0	.0	13.0	
1935														
Jan. 13	1	32	124	0				87.5	4.5	.0	.0	5.5	2.5	
	1	36	124	0				90.0	2.0	.0	.0	2.0	6.0	
Jan. 13 †	1	32	118	0				72.5	2.5	.0	14.5	3.5	7.0	
	1	36	115	0				63.0	1.5	.0	.5	3.0	32.0	
Jan. 13 ‡	1	32	114	0				54.5	2.5	.0	13.0	7.0	23.0	
	1	36	114	0				80.0	2.0	.0	.5	1.5	16.0	
1934														
Sept. 19	2	(9)	0			13.0		100.0	.0	.0	.0	.0	.0	
	2	32	56	0				65.5	1.0	.0	23.5	9.5	.5	
Nov. 13	2	36	55	0				86.0	2.0	.0	2.5	7.5	2.0	
	2	32	49	0				87.5	2.0	.0	2.5	4.0	4.0	
Nov. 13 †	2	36	49	0				98.0	3.6	.0	1.5	1.5	25.5	
	2	32	45	0				55.5	3.6	.0	2.5	5.5	33.0	
Nov. 13 ‡	2	36	46	0				48.5	4.6	.0	.5	7.5	39.0	
	2	32	82	0				73.5	.5	.0	8.5	10.0	1.5	
Dec. 10	2	36	82	0				84.5	.0	.0	4.5	7.5	3.5	
	2	32	70	0				77.0	.0	.0	15.5	2.5	5.0	
Dec. 10 †	2	36	70	0				75.0	2.5	.0	1.5	3.0	15.0	
	2	32	72	0				65.0	.0	.0	8.5	.0	26.5	
Dec. 10 ‡	2	36	72	0				63.0	.5	.0	.0	15.0	21.5	
1935														
Jan. 14	2	32	117	0				72.5	.0	.0	25.0	2.0	.5	
	2	36	117	0				76.0	.5	.0	1.0	12.0	10.5	
Jan. 14 †	2	32	111	0				78.5	1.5	.0	5.0	3.0	12.0	
	2	36	111	0				46.5	5.5	.0	.5	11.5	36.0	
Jan. 14 ‡	2	32	107	0				32.5	6.0	.0	0.0	4.5	43.0	
	2	36	107	0				29.5	2.5	.0	.0	6.5	64.5	

1935 CROP

Date	Pick No.	Temp.	Period	After ripening at 70° F.	Ground color No.†	Pressure test Lb.	Ripeness ‡	Sound Pct.	Decay Pct.	Internal break-down Pct.	Soft Pct.	Bruise Pct.	Jonathan spot Pct.	Desert quality †
1936														
Sept. 6	1	(9)	0	0	1.9	16.4	H	100.0	0.0	0.0	0.0	0.0	0.0	
Sept. 13	1	(9)	0	7	2.5	15.6	H-F	99.5	.5	.0	.0	.0	.0	
1938														
Jan. 29	1	32	145	0	3.1	11.1	FR	85.0	2.0	4.5	.0	.0	8.5	
	1	36	145	0				90.0	.0	.0	.0	.0	1.0	
Jan. 29 †	1	32	139	0				66.5	4.5	.0	20.5	.0	9.5	
	1	36	139	0				39.5	2.5	3.5	.5	.0	54.0	

<sup>1</sup> Sum of percentage may be more than 100, as apples showing more than 1 kind of disorder were counted in more than 1 category.

<sup>2</sup> Number on color chart, in which 1 represents green and 4 represents yellow.

<sup>3</sup> H=hard, F=firm, FR=firm ripe, R=ripe, OR=overripe. Italic letters indicate apples were mostly of that degree of ripeness.

<sup>4</sup> Fruit packed with oiled paper in 1937 season only, but no superficial scald developed on any lots.

<sup>5</sup> VG=very good, G=good, FG=fairly good.

<sup>6</sup> Not stored.

<sup>7</sup> Delayed 8 days at 65° F. in 1934 and 70° F. in 1935 seasons.

<sup>8</sup> Delayed 10 days at 65° F. in 1934 and 70° F. in 1935 seasons.

TABLE 7.—Effect of storage at 32° and 36° F. on Jonathan apples—Continued

1935 CROP—Continue 1

Date of examination	Pick No.	Storage		After ripening at 70° F., Days	Ground color No.	Pressure lost Lb.	Ripeness	Sound	Decay	Internal break-down	Scald		Jonathan spot	Dessert quality
		Temperature	Period								Soft	Drains		
1936														
Feb. 8	1	° F.	Days	Days		Lb.		Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	
		32	145	8				62.0	6.5	23.0	0.0	0.0	0.0	G
		36	145	8				92.0	5.0	0.0	0.0	0.0	0.0	
Feb. 6 <sup>1</sup>	1	32	139	8				47.5	13.5	5.0	26.5	0.0	13.5	
		36	130	8				29.0	13.5	5.5	0.0	0.0	52.0	
1935														
Sept. 19	2	(9)	0	0	2.8	14.3	F	100.0	0.0	0.0	0.0	0.0	0.0	G
		(9)	0	5	3.4	13.0	F-FR	90.5	5.0	0.0	0.0	0.0	0.0	
Sept. 24	2	32	72	0	3.7	15.1	H-F	90.5	1.0	0.0	2.5	0.0	0.0	VG
Nov. 30	2	36	72	0	3.8	14.0	F-FR	99.5	5.0	0.0	0.0	0.0	0.0	VG
		32	72	7	4.0 <sup>+</sup>	13.3	F-FR	80.5	1.0	16.0	2.5	0.0	0.0	VG
Dec. 7	2	36	72	7	4.0 <sup>+</sup>	11.9	FR	91.0	0.0	8.0	1.0	0.0	0.0	VG
1936														
Jan. 29	2	32	132	0	3.0	11.8	F-FR	83.5	2.0	2.5	9.5	0.0	2.5	
		36	132	0	3.8	10.0	FR	80.5	2.5	6.0	0.0	0.0	11.0	G
Jan. 29 <sup>1</sup>	2	32	129	0				86.5	2.5	3.0	3.5	0.0	7.0	
		36	129	0				89.0	5.0	2.0	0.0	0.0	8.5	
Jan. 29 <sup>2</sup>	2	32	126	0				45.5	2.5	8.0	33.0	0.0	32.0	
		36	126	0				64.5	2.5	1.0	5.0	0.0	31.5	
Jan. 29 <sup>3</sup>	2	32	123	0				32.0	2.0	2.0	34.0	0.0	42.0	
		36	123	0				29.5	11.5	4.5	7.0	0.0	60.0	
1936														
Feb. 6	2	32	132	8	3.8	10.8	FR-R	62.5	3.5	25.5	6.0	0.0	4.5	
		36	132	8	4.0	11.1	FR-R	53.5	11.0	18.5	5.0	0.0	25.0	
Feb. 6 <sup>1</sup>	2	32	126	8				35.5	8.0	13.0	36.0	0.0	27.0	
		36	126	8				60.0	9.0	3.5	5.0	0.0	32.5	
Feb. 6 <sup>10</sup>	2	32	123	8				27.0	20.5	8.5	35.5	0.0	35.0	
		36	123	8				26.0	15.0	14.0	5.0	0.0	40.5	
1935														
Sept. 30	3	(9)	0	0	3.1	15.8	H-F	100.0	0.0	0.0	0.0	0.0	0.0	
Oct. 7	3	(9)	0	7	8.6	12.5	F-FR	90.5	5.0	0.0	0.0	0.0	0.0	
1936														
Jan. 29	3	32	121	0	3.0	12.0	F-FR	80.5	3.0	0.0	16.0	0.0	5.0	
		36	121	0				84.0	2.5	5.0	0.0	0.0	13.0	
Jan. 29 <sup>1</sup>	3	32	116	0				71.0	2.5	0.0	25.0	0.0	1.5	
		36	115	0				82.5	2.5	5.0	5.0	0.0	14.0	
Feb. 6	3	32	121	8		11.1	FR-R	53.0	7.5	7.5	16.5	0.0	19.5	
		36	121	8				69.0	9.5	4.0	0.0	0.0	17.5	
Feb. 6 <sup>1</sup>	3	32	115	8				62.5	4.0	4.5	25.0	0.0	4.0	
		36	115	8				62.0	17.0	5.0	0.0	0.0	23.5	

1936 CROP

1938														
Sept. 18		(9)	0	0	2.3	16.1	H-F	100.0	0.0	0.0	0.0	0.0	0.0	G
Sept. 25		(9)	0	7	3.0	13.9	F-FR	97.5	0.0	0.0	0.0	0.0	2.5	
Nov. 18		32	61	0	2.8	13.5	F-FR	96.5	5.0	0.0	1.5	0.0	1.5	VG
		36	61	0	2.7	10.8	FR-R	97.5	2.0	0.0	0.0	0.0	5.5	G-VG
		32	61	7	3.3	10.3	FR-R-OR	82.5	3.0	7.0	4.0	0.0	1.5	VG
Nov. 25		30	61	7	3.4	9.6	R-OR	69.0	3.5	24.0	0.0	0.0	3.5	G

<sup>4</sup> Not stored.

<sup>7</sup> Delayed 6 days at 65° F. in 1934 and 70° F. in 1935 seasons.

<sup>8</sup> Delayed 3 days at 65° F. in 1934 and 70° F. in 1935 seasons.

<sup>10</sup> Delayed 9 days at 65° F. in 1934 and 70° F. in 1935 seasons.

TABLE 7.—Effect of storage at 32° and 36° F. on Jonathan apples—Continued

1936 CROP—Continued

Date of examination	Pick No.	Storage		After ripening at 70° F.	Ground color No.	Pressure test	Ripeness	Sound	Decay	Internal break-down	Scald		Jonathan spot	Dessert quality
		Temperature	Period								Soft	Bruises		
1937														
Feb. 4	32	° F.	Days	Days	Lb.		Pct.	Pct.	Pct.	Pct.	Pct.	Pct.		
		139	0	2.5	11.4	FR	93.5	4.5	.0	.0	.0	2.0	G	
Feb. 11	32	139	0	3.3	9.4	R	54.0	3.5	1.5	.0	.0	41.0	FG	
		139	7	3.1	11.0	FR-R	70.0	11.0	3.0	.5	.0	15.5	G+	
Mar. 18	32	139	7	3.6	10.5	R-OR	21.5	10.0	11.5	.0	.0	57.0	G	
		181	0	2.7	10.7	FR-R	67.5	4.0	.0	7.5	.0	21.0	G	
	36	181	0	3.1	11.0	FR-R	70.0	5.0	3.0	.0	.0	62.0	FG	
1937 CROP														
1937														
Sept. 14	(9)	0	0	1.9	16.2	H-F	100.0	0.0	0.0	0.0	0.0	0.0	G	
Sept. 21	(6)	0	7	2.7	14.9	FR	100.0	.0	.0	.0	.0	.0	G	
Nov. 15	32	62	0	2.3	14.2	F-FR	100.0	.0	.0	.0	.0	.0	G-VG	
	36	62	0	2.5	12.0	FR	100.0	.0	.0	.0	.0	.0	G-VG	
Nov. 22	32	62	7	2.9	12.5	FR-OR	92.0	.0	6.0	2.0	.0	.0	G-VG	
	36	62	7	3.0	11.3	FR-R-OR	95.5	.0	4.5	.0	.0	.0	G	
1938														
Jan. 14	32	122	0	2.4	12.1	FR	97.5	2.5	.0	.0	.0	.0	G	
Jan. 21	36	122	0	2.6	10.7	FR-R	97.5	2.0	.5	.0	.0	.0	G	
	32	122	7	3.0	11.5	FR	90.5	.0	5.5	1.5	.5	2.0	G-VG	
	36	122	7	3.3	11.0	FR-R	91.5	.5	4.0	.0	.0	4.0	G	

\* Not stored.

In the 1934 crop little decay and no break-down occurred. There was more soft scald at 32° F., but more Jonathan spot at 36°. These results do not indicate any difference in desirability between 32° and 36° storage. The relative ripeness and dessert quality was not determined with these apples. In the 1935 crop also there was no consistent difference between the percentages of sound fruit at the two storage temperatures. Neither was any difference in dessert quality noted. With comparable lots in which firmness and ripeness were determined, the data show that the apples from 36° storage were softer and riper. This would indicate that 32° storage is somewhat preferable. In 1936 very little soft scald developed, but considerable Jonathan spot occurred, principally at 36°, and consequently there was a greater percentage of sound fruit after storage at 32°. The apples were also of higher dessert quality and were not so soft and ripe as those stored at 36°. The results for this season therefore distinctly indicate 32° for the storage temperature. With the 1937 crop the percentage of sound fruit was high at both temperatures at all inspections. The apples from 36° storage were softer and riper, and when ripened at 70° were less desirable in dessert quality than apples from 32°. Thus somewhat better results were obtained by storage at 32° for this season also.

On the basis of the results for the four seasons, storage at 32° gave better results with the Jonathan variety, because of the more rapid ripening and poorer dessert quality obtained at 36°. The data also indicate that storage immediately after picking was an important factor in obtaining the best results.

#### ROME BEAUTY

The effect of storage at 32° and at 36° is shown in table 8 for Rome Beauty apples. The main market season for this variety is November to May (19). There was little or no difference between the ground color of apples stored for 2 months at 32° and at 36°. With longer storage, apples held at 36° were generally distinctly more yellow. The fruit was generally riper and softer at 36° than at 32°. Considerable decay developed in these lots, but there was no consistent difference that could be related to the temperatures. Although the mean difference showed 5.4 percent more decay at 36°, this difference was not statistically significant. Practically no break-down occurred except in the 1937 season, and then there was no consistent difference between lots stored at the two temperatures. The apples were packed in oiled paper in 1935 and in 1936, and practically no scald occurred. In 1937 no oiled paper was used, and considerable scald showed on the apples from 32° at the final inspection. After 4 to 6 months' storage, rather severe spot (apparently Jonathan spot) developed, which was very much more severe at 36°. Principally because of the spotting at 36° there was generally more sound fruit at 32°. There was a gradual decline in dessert quality during storage, and this was more marked at 36° than at 32°.

In all three seasons the fruit was softer, riper, and of poorer dessert quality, and developed more (Jonathan) spot at 36° F. than at 32°. These results, therefore, indicate 32° for the storage temperature for Rome Beauty apples, although for short storage of 2 months or less 36° would be equally satisfactory.



TABLE 8.—Effect of storage at 32° and 36° F. on Rome Beauty apples

1935 CROP

Date of examination	Storage		After ripening at 70° F.	Ground color No.	Pressure test	Ripeness <sup>1</sup>	Sound	Decay	Internal break-down	Scald <sup>2</sup>	Other disorders	Dessert quality <sup>3</sup>
	Temperature	Period										
<i>1935</i>												
Oct. 27	° F. (2)	Days	Days	Lb.			Pct.	Pct.	Pct.	Pct.	Pct.	
Nov. 4	(2)	0	0	2.9	18.8	H-F	100.0	0.0	0.0	0.0	0.0	0.0
		0	8	3.3	14.0	F	100.0	0.0	0.0	0.0	0.0	
	32	62	0	3.5	14.4	F-FR	100.0	0.0	0.0	0.0	0.0	
Dec. 23	36	62	0	3.5	13.5	F-FR	99.0	1.0	0.0	0.0	0.0	VG
<i>1936</i>												
Jan. 4	32	62	7	3.0	12.7	FR	100.0	0.0	0.0	0.0	0.0	VG
	36	62	7	3.5	12.0	FR	97.0	3.0	0.0	0.0	0.0	VG
	32	121	0	3.3	11.0	FR	97.0	2.5	0.0	0.0	0.0	G
Feb. 25	30	121	0	3.4	10.8	FR-R	100.0	0.0	0.0	0.0	0.0	G
	32	121	7	3.8	11.2	FR-R	97.0	2.5	0.0	0.0	0.0	G
Mar. 3	30	121	7	4.0	11.1	R	90.0	0.0	0.0	0.0	0.0	10.0
	32	186	0	2.7	11.3	FR-R	74.5	2.5	0.0	0.0	0.0	G-F
Apr. 30	36	186	0	3.6	11.1	R	59.5	3.5	1.0	0.0	0.0	F
	32	186	6				61.5	12.5	0.0	0.0	0.0	F-P
May 6	36	186	6				46.5	11.5	2.0	0.0	0.0	F-P

1936 CROP

<i>1936</i>												
Oct. 17	(2)	0	0	2.5	18.9	F	100.0	0.0	0.0	0.0	0.0	
Oct. 24	(2)	0	7	2.8	15.4	FR	98.0	.5	1.5	0.0	0.0	
	32	51	0	1.4	10.0	F-FR	100.0	0.0	0.0	0.0	0.0	G
Dec. 17	36	51	0	2.1	13.4	FR-R	99.5	.5	0.0	0.0	0.0	G
	32	61	7	2.9	12.4	FR-R	94.5	4.5	1.0	0.0	0.0	FG
Dec. 24	36	61	7	2.6	11.6	FR-R	90.5	9.5	.9	0.0	0.0	FG
<i>1937</i>												
Feb. 17	32	123	0	2.2	12.8	F-FR	98.0	2.0	0.0	0.0	0.0	G
	36	123	0	3.0	11.8	FR-R	86.0	2.0	0.0	0.0	0.0	FG
Feb. 24	32	123	7	2.2	12.1	FR-R	80.0	17.0	0.0	1.0	0.0	12.0
	36	123	7	2.9	11.3	R	65.5	22.5	0.0	0.0	0.0	12.0
Apr. 15	32	180	0	1.8	13.9	FR	88.0	8.5	0.0	.5	0.0	3.0
	36	180	0	2.8	12.8	FR-R	68.5	3.5	0.0	3.0	0.0	25.0
Apr. 22	32	180	7	2.6	13.0	FR-R	66.0	22.0	0.0	7.0	0.0	75.0
	36	180	7	3.8	12.0	FR-R	37.0	28.5	1.0	3.5	0.0	30.0

1937 CROP

<i>1937</i>												
Oct. 11	(2)	0	0	2.3	21.2	F	100.0	0.0	0.0	0.0	0.0	
Oct. 18	(2)	0	7	2.5	18.1	F	100.0	0.0	0.0	0.0	0.0	G-VG
<i>1938</i>												
Jan. 11	32	92	0	2.3	16.2	F	99.5	.5	0.0	0.0	0.0	FG
	36	92	0	3.0	15.1	FR	97.0	2.5	.5	0.0	0.0	G-VG
Jan. 18	32	92	7	2.9	13.6	FR-OR	81.0	1.5	17.5	0.0	0.0	G
	36	92	7	3.6	13.4	FR-OR	78.0	3.5	18.5	0.0	0.0	G
Apr. 11	32	182	0	2.5	15.2	FR	94.0	1.5	2.0	.5	0.0	2.0
	36	182	0	2.9	13.9	FR-R	38.5	15.0	4.5	.5	0.0	41.5
Apr. 18	32	182	7	2.8	13.7	R-OR	32.5	17.0	21.5	29.0	0.0	0.0
	36	182	7	3.4	13.0	R-OR	10.0	75.0	5.5	3.0	0.0	18.5

<sup>1</sup> Number on color chart, in which 1 represents green and 4 represents yellow.

<sup>2</sup> H=hard, F=firm, FR=firm ripe, R=ripe, OR=overripe. Italic letters indicate apples were mostly of that degree of ripeness.

<sup>3</sup> VG=very good, G=good, FG=fairly good, F=fair, P=poor.

<sup>4</sup> Not stored.

<sup>5</sup> Severe shrivel.

<sup>6</sup> Spotting similar to Jonathan spot.

## STAYMAN WINESAP

The effect of storage of Stayman Winesap apples at 32° and at 36° F. is shown in table 9 for three seasons. The main market season for this variety is November to April (19), and the inspections were made within this period. The ground color of the 1935 and 1937 apples became more yellow at 36° than at 32°, but not of the 1936 apples. The apples were generally distinctly softer and riper after storage at 36°, and somewhat less desirable dessert quality was frequently noted at this temperature. There was no consistent difference between the amounts of decay that developed at the two temperatures during all three seasons. Considerable break-down developed in apples of the 1935 and 1936 crops and was generally more severe after storage at 36°. Considerable scald developed, particularly in fruit of the last two seasons, even though the apples were packed in oiled paper. Although rather large differences in the amount of scald were apparent in apples from the two temperatures, these differences were not consistently greater at either temperature.

The fruit of the 1935 crop was generally softer and riper and there were fewer sound apples after storage at 36° F. than at 32°. This would indicate 32° as the better storage temperature for periods of 4 to 6 months, although either temperature was suitable for 2 months. Apples of the 1936 crop stored at 36° were softer and riper and of poorer dessert quality than those at 32°. There was generally more sound fruit after 32° storage, and this temperature was again superior to 36° for storage. Likewise the apples stored at 36° in 1937 were softer and riper and of poorer dessert quality than those stored at 32°. There was no significant difference in the percentage of sound fruit after 3 months' storage. On removal after 6 months' storage there was a greater percentage of sound fruit from 32° than from 36° storage, but at the end of the after-ripening period the greater percentage of sound fruit was from 36° storage. The results for this season indicate that either temperature was satisfactory for 3 months' storage, and that neither temperature was satisfactory after 6 months' storage, as severe decay and scald developed in apples from both temperatures during ripening. The data for all three seasons indicate that 32° was preferable to 36° for storage of Stayman Winesap apples.

TABLE 9.—Effect of storage at 32° and 36° F. on Stayman Winesap apples

1935 CROP

Date of examination	Storage		After ripening at 70° F.	Ground color No. 1	Pressure test	Ripeness 2	Stippled	Decay	Internal break-down	Scald 3	Severe shrivel	Descript. quality 4
	Temperature	Period										
1935												
Oct. 18	32	0	0	2.2	16.8	H-F	100.0	0.0	0.0	0.0	0.0	
Oct. 25	32	0	0	2.6	13.7	F-FR	100.0	0.0	0.0	0.0	0.0	
Dec. 17	32	60	0	3.0	15.0	F-FR	100.0	0.0	0.0	0.0	0.0	G
Dec. 24	32	60	0	3.0	11.6	FR	98.0	2.0	0.0	0.0	0.0	VG
	36	60	7	3.4	11.2	FR-R	97.5	1.0	1.5	0.0	0.0	VG
1936												
Feb. 18	32	123	0	2.7	10.0	FR	69.0	1.0	2.0	0.0	0.0	
	36	123	0	2.0	10.2	FR	83.5	4.5	2.0	0.0	0.0	
Feb. 25	32	123	7	2.9	10.9	FR-R	92.5	5.5	2.0	0.0	0.0	
	36	123	7	3.5	9.8	R	78.0	14.0	7.0	3.0	0.0	
Apr. 14	32	179	0	2.7	11.8	FR-R	91.5	5.5	5.0	0.0	0.0	F
	36	179	0	3.2	11.1	FR-R	96.0	2.5	1.5	0.0	0.0	F
Apr. 21	32	179	7	3.0	11.3	FR-R	61.0	23.5	5.0	7.5	0.0	
	36	179	7	4.0	10.9	FR-R	47.0	22.5	11.0	12.5	0.0	

1936 CROP

1936												
Oct. 12	(3)	0	0	2.4	16.4	H	100.0	0.0	0.0	0.0	0.0	
Oct. 20	(3)	0	0	2.3	14.4	FR	99.5	.5	.0	.0	.0	
Dec. 11	32	60	0	1.5	16.0	F-FR	100.0	.0	.0	.0	.0	G-VG
	36	60	0	1.8	11.7	FR	100.0	.0	.0	.0	.0	G
Dec. 18	32	60	7	2.8	10.2	R	97.0	3.0	.0	.0	.0	O+
	36	60	7	2.7	10.0	R-OR	90.0	.5	0.5	.0	.0	G
1937												
Feb. 12	32	123	0	2.0	12.7	FR	100.0	.0	.0	.0	.0	VG
	36	123	0	1.8	10.7	H	91.5	.0	.5	8.0	.0	G-F
Feb. 19	32	123	7	2.8	11.7	FR-R-OR	72.5	.5	3.0	19.0	.0	G
	36	123	7	2.6	9.9	R-OR	58.0	1.0	12.5	28.5	.0	F+
Apr. 12	32	182	0	2.0	10.8	R	77.5	1.5	.5	19.5	2.0	G+
	36	182	0	2.1	10.9	R-OR	67.5	4.0	8.0	5.5	.0	G
Apr. 19	32	182	7	2.8	11.0	R-OR	48.5	4.0	8.5	39.0	.0	FG+
	36	182	7	2.6	10.6	R-OR	40.0	18.0	19.0	23.0	.0	FG

1937 CROP

1937												
Oct. 13	(3)	0	0	1.9	17.3	H-F	100.0	0.0	0.0	0.0	0.0	
Oct. 20	(3)	0	7	2.3	13.8	F-FR	100.0	.0	.0	.0	.0	VG
1938												
Jan. 13	32	92	0	2.5	14.8	F-FR	100.0	.0	.0	.0	.0	VG
	36	92	0	2.5	12.5	FR	99.5	.5	.0	.0	.0	VG-G
Jan. 20	32	92	7	2.0	11.6	FR-R	97.5	1.5	1.0	.0	.0	VG-O+
	36	92	7	2.8	11.2	FR-R	90.0	2.5	1.5	.0	.0	VG-G
Apr. 13	32	182	0	2.7	12.1	FR	95.5	2.0	.0	1.5	.0	VG
	36	182	0	3.2	10.9	FR-R	85.5	14.0	.0	1.5	.0	G
Apr. 20	32	182	7	2.9	11.1	R	23.0	28.0	.0	49.0	.0	VG-G
	36	182	7	3.5	10.6	R+	38.5	39.5	2.0	20.0	.0	G

1 Number on color chart, in which 1 represents green and 4 yellow.  
 2 H=hard, F=firm, FR=firm ripe, R=ripe, OR=overripe. Italic letters indicate apples were mostly of that ripeness.  
 3 Apples packed in oiled paper in 1936 and 1937, but not in 1935.  
 4 VG=very good, G=good, FG=fairly good, F=fair.  
 5 Not stored.

**WEALTHY**

The effect of storage at 32° and at 36° F. on Wealthy apples is shown in table 10. The main market season for this variety extends from October to December (19). During both seasons the apples of this variety were subject to growth cracks, particularly around the stem. Apples with large cracks were sorted out, but it was not possible to eliminate all cracking. Consequently the apples were rather

subject to decay, particularly black rot, which was prevalent in the orchard from which these apples were obtained. Decay was consistently more severe at 36° than at 32°. Some scald developed, particularly during afterripening at 70°, but there was no consistent difference between fruit stored at the two temperatures. In the 1935 crop, a disorder resembling soft scald developed on some of the apples from 36°, but not on those from 32° storage. There was no appreciable difference between fruit from the two temperatures in the changes in ground color, in firmness, or in ripeness, and very little difference in dessert quality.

In 1935 the fruit stored for 2½ months held up better at 32° than at 36° F. After 4½ months, which was rather long storage for this variety, the apples from 32° storage were in better condition at the time of removal; but neither lot held up for as much as a week at room temperature (70°). In 1936 there was very little difference between the apples from 32° and 36° in most respects, but the dessert quality was somewhat better at 32°. On the basis of these results, 32° is indicated as the storage temperature for the Wealthy variety, as it was somewhat superior the first season and was equally satisfactory or slightly better the second season.

TABLE 10.—Effect of storage at 32° and 36° F. on Wealthy apples  
1935 CROP

Date of examination	Storage		After ripening at 70° F.	Ground color No. 1	Pressure test	Ripeness 1	Sound	Decay	Internal break-down	Soft 1	Other disorders	Dessert quality 1
	Temperature	Period										
1935												
Aug. 14	° F.	Days	Days	Lb.		Pct.	Pct.	Pct.	Pct.	Pct.		
Aug. 21	(2)	0.0	0	1.9	13.0	100.0	0.0	0.0	0.0	0.0		
Aug. 21	(2)	0	7	2.3	9.8	FR-R	86.0	20.0	.0	.0		
Oct. 30	32	77	0	2.6	12.0	F-FR	97.5	2.5	.0	.0		
	36	77	0	2.3	12.0	FR	83.5	10.5	.0	.0		
Nov. 6	32	77	7	2.8	10.3	FR-R	72.5	24.0	1.0	2.5		
	36	77	7	3.1	10.2	FR	52.0	34.0	.0	11.5	*2.5	
Dec. 30	32	138	0	2.8	11.6	FR	82.5	17.5	.0	.0		
	36	138	0	3.0	11.8	FR	55.0	33.0	.0	.0	*12.0	
1936												
Jan. 6	32	138	7		10.0	R	9.0	49.5	.0	41.5	.0	
	36	138	7		9.2	R+	24.0	49.0	.0	13.0	*14.0	
1936 CROP												
1936												
Aug. 21	(2)	0	0	1.1	15.8	H-F	100.0	0.0	0.0	0.0		
Aug. 28	(2)	0	7	1.0	12.0	F-FR	84.5	15.5	.0	.0		
Sept. 21	32	31	0	1.1	14.1	F-FR	91.0	1.5	.0	7.5	.0	
	36	31	0	1.3	13.3	FR	92.5	6.0	.0	1.5	.0	
Sept. 28	32	31	7	1.1	10.5	FR	68.0	32.0	.0	.0		
	36	31	7	1.0	10.0	FR	70.0	30.0	.0	.0		
Oct. 21	32	61	0	1.3	12.2	FR	87.5	12.5	.0	.0		
	36	61	0	1.2	12.8	FR	78.5	21.5	.0	.0		
Oct. 28	32	61	7	2.1	10.9	R	56.0	38.5	.0	5.5	.0	
	36	61	7	1.5	9.8	R	56.5	43.5	.0	.0		
Nov. 19	32	90	0	1.2	11.8	FR-R	77.5	18.5	3.6	.0	7.5	
	36	90	0	1.1	10.8	R	70.5	20.0	3.5	.0	.0	
Nov. 25	32	90	6	1.3	9.4	R	59.0	35.0	5.0	.0	*1.0	
	36	90	6	1.3	9.1	R	43.5	39.5	5.0	12.0	.0	

1 Number on color chart, in which 1 represents green and 4 represents yellow.

2 H=hard, F=firm, FR=firm ripe, R=ripe. Italic letters indicate apples were mostly of that degree of ripeness.

3 Not packed in oiled paper.

4 G=good, FG=fairly good, F=fair, P=poor.

5 Not stored.

6 Soft scald or a disorder closely resembling it.

7 Severe shrivel.

## WINESAP

The effect of storage at 32° and at 36° F. on Winesap apples is shown in table 11. The picking in 1935 was made rather late in the season, and a large part of the crop had dropped. The apples were almost entirely covered with red, so the ground color could not be determined. In the subsequent seasons the fruit was picked earlier and was harder. The main market season for Winesap apples is January to May (19). The first inspections of the 1935 and the 1936 seasons were made somewhat early for this variety and, therefore, are not as important as the later inspections. Relatively few storage disorders developed on these lots, and there was no consistent or significant difference in the percentages of decay, break-down, or scald after storage at the two temperatures. When ripened at 70° after 6 months' storage there was more decay and break-down at 32° in the 1935 lot, and more decay and scald at 32° in the 1937 lot; but there was more decay, break-down, and scald at 36° in the 1936 lot. However, there was no consistent difference in the percentage of sound fruit at the two temperatures. The development of yellow ground color was not more rapid at 36° than at 32° during the two seasons in which determinations were made. The apples at 36° were distinctly softer and riper. No appreciable difference in dessert quality was noted in 1935 or in 1937 lots. The fruit of the 1936 crop, however, was generally superior in dessert quality after storage at 32°.

The results indicate that either 36° or 32° would be satisfactory for storage of Winesap apples for 2 to 3 months. Because this variety is generally stored longer than this, 32° storage would be preferable because of the less ripe and mealy condition and probably superior dessert quality. However, in two of the three seasons there was a higher percentage of sound fruit at 36° when afterripened following 6 months' storage. In the other season the percentage of sound fruit was higher at 32°.

TABLE 11.—Effect of storage at 32° and 36° F. on Winesap apples  
1935 CROP

Date of examination	Storage		After ripening at 70° F.	Ground color No. 1	Pressure test	Ripeness 2	Sound	Decay	Internal break-down	Starch 3	Severe shrivel	Dessert quality 4
	Temperature	Period										
1935												
Oct. 24	32	0	0	19.1		H	100.0	0.0	0.0	0.0	0.0	
Oct. 31	32	0	7	18.0		H	98.5	1.5	0.0	0.0	0.0	
Dec. 24	32	61	0	18.3		H-F	100.0	0.0	0.0	0.0	0.0	
	36	61	0	10.9		H-F	97.0	3.0	0.0	0.0	0.0	
Dec. 31	32	61	7	16.3		F-FR	93.0	2.0	0.0	0.0	0.0	G
	36	61	7	14.6		F-R	93.5	5.5	0.0	0.0	0.0	G
1936												
Feb. 25	32	124	0	13.7		FR	97.0	3.0	0.0	0.0	0.0	
	36	124	0	12.0		R	98.0	2.0	0.0	0.0	0.0	
Mar. 3	32	124	7	14.5		F-FR	94.0	5.0	0.0	0.0	1.0	
	36	124	7	14.0		FR	90.0	5.0	5.0	0.0	0.0	
Apr. 28	32	187	0	14.5		FR	86.5	11.0	1.5	1.0	0.0	
	36	187	0	13.4		R	90.5	0.5	0.0	0.0	0.0	
May 5	32	187	7	14.0		FR-R	61.0	29.5	8.5	1.0	0.0	F
	36	187	7	13.0		R	74.5	19.5	3.5	2.5	0.0	F

1936 CROP

1936												
Oct. 12	32	0	0	2.9	22.1	H	100.0	0.0	0.0	0.0	0.0	
Oct. 20	32	0	8	3.1	17.2	F-FR	100.0	0.0	0.0	0.0	0.0	
Dec. 11	32	60	0	2.2	21.3	H	100.0	0.0	0.0	0.0	0.0	
	36	60	0	2.8	16.9	F	100.0	0.0	0.0	0.0	0.0	
Dec. 18	32	60	7	3.6	15.3	F-FR	100.0	0.0	0.0	0.0	0.0	G
	36	60	7	3.5	13.9	FR-R	99.0	1.0	0.0	0.0	0.0	G
1937												
Feb. 13	32	124	0	3.1	16.8	F	96.5	0.5	0.0	0.0	1.0	G
	36	124	0	2.9	13.7	FR	99.5	0.5	0.0	0.0	0.0	G-F
Feb. 20	32	124	7	3.3	13.8	FR	95.5	3.0	0.5	0.0	1.0	G
	36	124	7	3.0	12.5	FR-R	99.0	1.0	0.0	0.0	0.0	F
Apr. 12	32	182	0	2.9	14.6	FR	86.0	1.0	0.0	0.0	14.0	G
	36	182	0	3.2	13.3	FR-R	99.0	1.0	0.0	0.0	0.0	F
Apr. 19	32	182	7	3.6	14.0	FR	94.5	1.5	0.5	0.0	3.0	G
	36	182	7	3.6	12.0	R	88.0	4.5	2.0	5.5	0.0	G-F

1937 CROP

1937												
Oct. 6	32	0	0	3.0	24.1	H	100.0	0.0	0.0	0.0	0.0	
Oct. 13	32	0	7	3.0	19.4	H-F	100.0	0.0	0.0	0.0	0.0	G
1938												
Jan. 6	32	92	0	3.3	19.4	H-F	100.0	0.0	0.0	0.0	0.0	F-G
	36	92	0	3.4	18.7	F	100.0	0.0	0.0	0.0	0.0	G
Jan. 13	32	92	7	3.6	17.3	F	99.5	0.0	0.5	0.0	0.0	FG
	36	92	7	3.5	15.0	FR-R	100.0	0.0	0.0	0.0	0.0	FG
Apr. 7	32	183	0	3.4	17.2	F	100.0	0.0	0.0	0.0	0.0	G
	36	183	0	3.5	16.1	FR	98.5	1.5	0.0	0.0	0.0	G
Apr. 14	32	183	7	3.9	15.2	FR	50.0	9.0	0.0	41.0	0.0	G
	36	183	7	3.9	14.4	R	84.5	4.0	0.0	8.5	3.0	G-FG

1 Number on color chart, in which 1 represents green and 4 represents yellow. In 1935 ground color was covered by red color.

2 H=hard, F=firm, FR=firm ripe, R=ripe. Italic letters indicate apples were mostly of that degree of ripeness.

3 All lots packed in oiled paper.

4 G=good, FG=fairly good, F=fair.

5 Not stored.

## YELLOW NEWTOWN (ALBERMARLE PIPPIN)

The effect of storage at 32° and 36° F. on Yellow Newtown apples is shown in table 12. The pickings of this variety for the storage tests were made the latter part of October, although this variety is frequently picked commercially much earlier in Virginia. However, for best storage a relatively late picking is recommended (16). The main marketing season for this variety is given as January to May (19). The first inspection of apples of the 1936 season was somewhat early and consequently of less importance than the later inspections. The ground color at the time of picking ranged from 1.4 to 1.9 in the different seasons. As the apples became more yellow in storage, they became rather mottled, which made it difficult to accurately estimate the ground color. During the three seasons there was no consistent difference in ground color between apples from the two temperatures. Although the apples from 36° storage were generally softer than those from 32° storage, the differences were not great and the fruit from 36° storage was sufficiently firm for good marketing condition. The difference in ripeness as estimated by tasting was slight or imperceptible. Decay was prevalent in these lots after long storage and averaged somewhat higher at 36°. The amount of decay was variable. Based on those lots only in which at least 5 percent of decay occurred at one of the temperatures, an analysis of variance indicated that the difference in decay at the two temperatures was barely significant. Severe shriveling and bitter pit were noted. Pitting occurred only at 36°, but shriveling was usually more severe at 32° because of somewhat lower humidity in the 32° room. In the few instances in which scald occurred, it was more severe at 36°. The dessert quality was generally distinctly superior in the apples from 32° storage.

For the 1935 crop, storage at either 32° or 36° F. was equally satisfactory for 4 months. For 6 to 8 months' storage, 32° was superior to 36° because of the greater amount of decay at 36° and the better dessert quality at 32°. In lots of the 1936 apples removed from storage in February and April, there was more sound fruit at the time of removal, in the lots stored at 36°, but after a week at room temperature there was more sound fruit in the lots stored at 32°. The condition of the fruit after a period at room temperature should be more important than its condition on removal. The results, therefore, indicate that 32° is the preferable storage temperature because of the better dessert quality and higher percentage of sound fruit after ripening. With the 1937 crop there was no appreciable difference between 32° and 36° storage after 3 months except that slightly better dessert quality was noted in the apples from 32° storage. At the end of 6 months, 32° storage was superior because of the higher percentage of sound fruit and the distinctly superior dessert quality at this temperature. Therefore, when all three seasons are considered, the results indicate that for short storage either 32° or 36° might be used for Yellow Newtown, but for storage of 4 months or more 32° should be used. However, when grown under conditions that make this variety susceptible to internal browning a higher temperature (36° to 38°) should be used.

TABLE 12.—Effect of storage at 32° and 36° F. on Yellow Newtown apples

1935 CROP

Date of examination	Storage		After ripening at 70° F.	Ground color No. 1	Pressure test	Ripeness 1	Sound	Decay	Internal break-down	Solid 1	Other disorders	Dessert quality 1
	Temperature	Period										
Oct. 25 1935	° F. (3)	Days 0	Days 0	1.7	Lb. 19.2	H	Pct. 100.0	Pct. 0.0	Pct. 0.0	Pct. 0.0	Pct. 0.0	
Nov. 1	(3)	0	7	1.9	19.1	H	99.0	1.0	.0	.0	.0	
Feb. 27 1936	32	125	0	2.0	15.3	F	98.5	1.5	.0	.0	.0	
	36	125	0	2.2	13.8	F-FR	99.0	1.0	.0	.0	.0	
Mar. 5	32	125	7	2.4	13.8	F-FR	97.5	2.5	.0	.0	.0	
	36	125	0	2.9	13.0	F-FR	96.5	3.5	.0	.0	.0	
Apr. 28	32	186	0	1.9	12.6	R	93.5	6.5	1.0	.0	.0	G
	36	186	0	1.9	12.6	R	91.5	8.5	.0	.0	.0	F
May 5	32	186	7	2.7	12.6	R	80.0	19.0	1.0	.0	.0	G
	36	186	0	2.8	13.0	R	70.0	30.0	.0	.0	.0	F
June 26	32	245	0	2.3	11.8	FR-R	89.0	11.0	.0	.0	.0	F
	36	245	0	2.5	11.9	FR-R	77.5	22.5	.0	.0	.0	F-P

1936 CROP

Oct. 19 1936	(3)	0	0	1.9	19.0	F	100.0	0.0	0.0	0.0	0.0	
Oct. 26	(3)	0	7	1.9	17.9	H-F	99.0	1.0	.0	.0	.0	G
Dec. 9	32	51	0	1.5	18.8	H	91.0	.0	.0	.0	9.0	G
	36	51	0	1.6	17.9	H-F	97.0	.5	.0	.0	2.5	G
Dec. 16	32	51	7	2.0	17.3	F	96.5	5.5	.0	.0	8.0	VG
	36	51	7	1.9	16.8	F	85.0	3.0	.0	.0	12.0	G-VG
Feb. 9 1937	32	113	0	2.1	15.7	H-F	62.0	3.0	.0	.0	35.0	G-VG
	36	113	0	1.9	14.2	FR-R	77.5	3.0	.0	.0	15.0	G
Feb. 16	32	113	7	2.1	14.8	F-FR	72.0	12.0	.0	.0	16.0	G+
	36	113	7	2.3	13.2	FR	65.0	9.5	.0	.0	17.0	G
Apr. 9	32	172	0	1.7	14.8	FR	44.5	2.0	.0	.0	53.5	G
	36	172	0	3.0	14.8	FR	61.5	15.5	.0	.0	15.5	F-G
Apr. 16	32	172	7	1.6	13.2	FR	50.0	20.5	.5	.0	29.0	G
	36	172	7	2.9	13.1	FR-R	32.5	38.0	.0	22.0	7.5	F

1937 CROP

Oct. 21 1937	(3)	0	0	1.4	17.5	H	100.0	0.0	0.0	0.0	0.0	
Oct. 28	(3)	0	7	1.4	17.8	H-F	100.0	.0	.0	.0	.0	VG
Jan. 24 1938	32	95	0	1.8	17.5	H-F	89.0	1.0	.0	.0	.0	G
	36	95	0	1.5	16.0	F-FR	95.0	2.0	.0	.0	.0	G
Jan. 31	32	95	7	2.8	15.9	F	91.5	3.5	2.0	.0	.0	G-VG
	36	95	7	2.4	15.0	F	96.5	3.5	.0	.0	.0	G
Apr. 25	32	186	0	1.3	15.3	F-FR	90.0	4.0	.0	.0	.0	G
	36	186	0	2.4	14.8	F-FR	74.0	22.5	.0	3.0	7.5	F-P
May 2	32	186	7	2.5	14.5	FR	65.0	32.0	.0	3.0	.0	G-VG
	36	186	7	2.2	14.1	FR	21.0	67.0	.0	12.0	.0	F-P

1 Number on color chart, in which 1 represents green and 4 represents yellow.

2 H = hard, F = firm, FR = firm ripe, R = ripe. Italic letters indicate apples were mostly of that degree of ripeness.

3 Apples packed in oiled paper.

4 VG = very good, G = good, F = fair, P = poor.

5 Not stored.

6 Severe shrivel.

7 Bitter pit.



## YORK IMPERIAL

The effect of storage of York Imperial apples at 32° and at 36° F. is shown in table 13. In all three seasons the fruit used was picked toward the end of the commercial harvest season. The average firmness at harvest ranged from 18.6 to 21.3 pounds and the ground color from 2.0 to 2.6. The main market season for this variety extends from October to February (19). The last inspections of each season, therefore, were considerably beyond the usual marketing season and consequently should be given less weight than earlier inspections.

The results in table 13 indicate no consistent or marked difference in ground color of apples from storage at the two temperatures. The apples generally softened more rapidly and were riper after storage at 36°; however, the fruit did not become too soft or ripe during the main marketing season even at 36°. No very marked difference in dessert quality was noted in apples held at the two temperatures. Decay was the principal storage disorder to develop, and it did not differ consistently for the two temperatures, at least during the main marketing season. Slight scald developed with extended storage and was usually more severe at 36°.

In general, these results indicate that either 32° or 36° storage should be used for the York Imperial variety during its main marketing season, but that 32° may be somewhat preferable because of the firmer condition of the fruit and the somewhat better dessert quality. For storage extending beyond the main marketing season, 32° would be better.

TABLE 13.—Effect of storage at 32° and 36° F. on York Imperial apples

1935 CROP

Date of examination	Storage		After ripening at 70° F. <sup>1</sup>	Ground color No. <sup>1</sup>	Pressure test	Ripeness <sup>2</sup>	Sound	Decay	Internal break-down	Seeds <sup>3</sup>	Other disorders	Dessert quality <sup>4</sup>
	Temperature	Period										
1935												
Oct. 26	(5)	0	0	2.6	18.6	H-F	100.0	0.0	0.0	0.0	0.0	
Nov. 2	(5)	0	0	3.2	19.3	H	100.0	0.0	0.0	0.0	0.0	
Dec. 27	32	62	0	3.2	17.7	H-F	100.0	0.0	0.0	0.0	0.0	
	36	62	0	3.5	17.0	F-FR	100.0	0.0	0.0	0.0	0.0	
1936												
Jan. 3	32	62	7	3.7	17.0	F-FR	96.5	3.5	0.0	0.0	0.0	VG
	36	62	7	3.7	11.9	F-FR	99.9	1.0	0.0	0.0	0.0	VG
Mar. 10	32	136	0	3.8	15.6	F-FR	97.5	2.5	0.0	0.0	0.0	G
	36	136	0	3.9	13.8	FR	99.9	1.0	0.0	0.0	0.0	G
Mar. 17	32	136	7	3.9	15.0	FR-R	96.5	9.0	0.0	4.5	0.0	G
	36	136	7	3.9	13.6	FR-R	79.0	10.5	0.0	30.5	0.0	G
Apr. 29	32	186	0	3.4	12.2	R	97.5	2.5	0.0	0.0	0.0	G
	36	186	0	3.3	11.2	R	88.5	10.5	0.0	1.0	0.0	F
May 6	32	186	7	-	-	-	32.5	47.9	0.0	20.5	0.0	
	36	186	7	-	-	-	17.0	71.5	0.0	11.5	0.0	

1936 CROP

1936												
Oct. 27	(5)	0	0	2.5	21.3	H	100.0	0.0	0.0	0.0	0.0	
Nov. 5	(5)	0	0	2.9	21.7	H	98.5	3.5	0.0	0.0	0.0	G
Dec. 9	32	43	0	1.6	21.1	H	99.5	.5	0.0	0.0	0.0	G
	36	43	0	1.2	20.2	H-F	99.5	.5	0.0	0.0	0.0	G
Dec. 16	32	43	7	2.3	19.8	F	93.0	7.0	0.0	0.0	0.0	G+
	36	43	7	2.6	17.6	FR	97.5	2.5	0.0	0.0	0.0	G
1937												
Feb. 9	32	105	0	1.7	17.6	F	96.0	4.0	0.0	0.0	0.0	G
	36	105	0	2.4	15.6	FR	97.5	2.5	0.0	0.0	0.0	G
Feb. 16	32	105	7	3.3	16.8	F-FR	87.5	12.5	0.0	0.0	0.0	FG+
	36	105	7	2.7	15.6	FR	90.0	9.5	0.0	5.0	0.0	FG
Apr. 9	32	164	0	2.0	18.4	F-FR	92.5	2.5	0.0	0.0	0.0	G
	36	164	0	2.2	14.5	FR-R	91.5	6.0	0.0	5.5	2.5	G
Apr. 16	32	164	7	2.6	17.5	FR	81.0	13.0	0.0	3.0	2.0	G
	36	164	7	2.9	15.1	FR-R	33.5	52.0	0.0	14.5	0.0	F

1937 CROP

1937												
Oct. 26	(5)	0	0	2.0	19.9	H-F	100.0	0.0	0.0	0.0	0.0	
1938												
Jan. 26	32	92	0	2.4	19.6	H-F	100.5	.5	0.0	0.0	0.0	G
	36	92	0	2.4	18.0	F-FR	100.0	0.0	0.0	0.0	0.0	G
Feb. 8	32	92	13	3.5	15.4	FR	97.5	2.5	0.0	0.0	0.0	G+
	36	92	13	3.4	14.9	FR-R	81.5	17.5	1.0	0.0	0.0	G
Apr. 27	32	183	0	2.7	16.2	F-FR	91.5	5.5	0.0	0.0	0.0	G-VG
	36	183	0	2.6	15.2	FR	81.5	13.5	0.0	5.0	0.0	G-VG
May 4	32	183	7	3.1	14.3	FR-R	43.0	50.9	0.0	7.0	0.0	G
	36	183	7	3.1	14.2	FR-R	15.5	72.0	0.0	12.5	0.0	F-P

<sup>1</sup> Number on color chart, in which 1 represents green and 4 represents yellow.

<sup>2</sup> H = hard, F = firm, FR = firm ripe, R = ripe. Italic letters indicate apples were mostly of that degree of ripeness.

<sup>3</sup> Apples packed in oiled paper in 1935 and 1937 but not in 1936.

<sup>4</sup> VG = very good, G = good, FG = fairly good, F = fair, P = poor.

<sup>5</sup> Not stored.

<sup>6</sup> Severe shrivel.

<sup>7</sup> Bitter pit.

## AVERAGE RESULTS FOR ALL VARIETIES

FIGURE 1 shows on a percentage basis the averages of the 13 varieties for sound fruit and for amounts of decay, of break-down, of scald, and of other storage disorders. This is based on all lots and not just those that show at least 5 percent of a disorder. This chart shows results for only two periods of storage, such as were used in the 1937 season. With the longer storage varieties such as Arkansas, Ben Davis, Rome Beauty, Stayman Winesap, Winesap, Yellow Newtown, and York Imperial these two storage periods were approximately 3 and 6 months in 1937. In the 1935 and 1936 seasons the last inspection was after 6 months. The other inspections, after 2 and 4 months' storage, were averaged to correspond to the inspection after 3 months' storage in the 1937 season. With the shorter storage varieties, such as Bonum, Delicious, Golden Delicious, Grimes

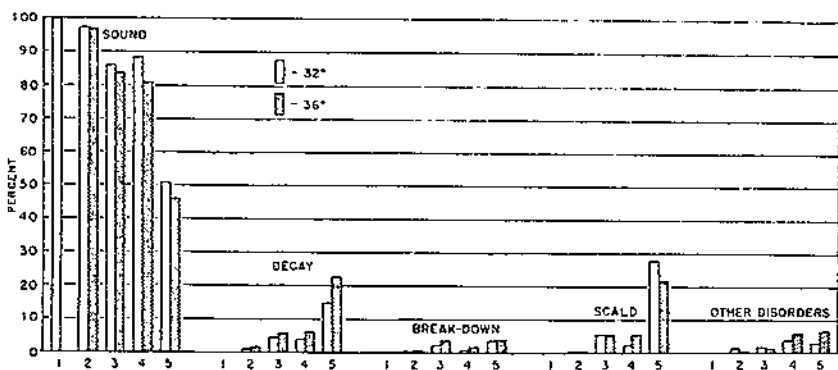


FIGURE 1.—Effect of storage at 32° and at 36° F. on wastage of apples. Averages of 13 varieties for three seasons: (1), Before storage; (2), storage for 2 or 3 months; (3), ripened 7 days at 70° after 2 or 3 months' storage; (4), storage for 4 or 6 months; (5), ripened 7 days at 70° after 4 or 6 months' storage. For details of storage periods, see text (p. 32).

Golden, Jonathan (comparable lots of Jonathan were not available in 1934, and only one picking of this variety in 1935 was used in the averages), and Wealthy, the data for 2 and 4 months' storage were used. Thus the columns in figure 1 represent averages of 13 varieties for 3 seasons (2 seasons for Ben Davis and Wealthy), with inspections made before storage (1); when removed from storage after 2 or 3 months at 32° and at 36° (2); when ripened (7 days) at 70° after 2 or 3 months' storage at 32° and at 36° (3); when removed from storage after 4 or 6 months at 32° and at 36° (4); and when ripened at 70° after 4 or 6 months' storage at 32° and at 36° (5).

The results indicate that practically no disorders developed during a week at room temperature immediately after harvest. The slight amount of decay was largely due to lots of the Wealthy varieties in which growth cracks were present. Likewise, the average percentage of disorders that developed in the fruit after 2 or 3 months' storage (2) was small. That the fruit had become riper and weaker, however, was indicated by the appreciable amounts of decay, break-down, and scald that developed when the apples were exposed to room tempera-

ture (70°) for a week (3). After 4 or 6 months' storage (4) considerable wastage was present in the fruit, and this became very severe with exposure to room temperature (5). At the time of removal from the low temperatures (4) all of the disorders averaged higher in the apples from 36° storage than in those from 32° storage.

The results in figure 1 indicate that with long storage the fruit may appear to be in good condition and not show excessive storage disorder, but may be so weakened that after removal from cold storage it rapidly deteriorates when exposed to relatively warm temperatures. This emphasizes the importance of prompt marketing and utilization of apples during the late storage period of a variety.

#### DEVELOPMENT OF DECAY IN RELATION TO STORAGE AT 32° AND 36° F.

Although isolations were not generally made to identify the organisms causing decay in the various lots, the symptoms on the fruit indicated that the decay was mainly black rot and blue mold rot. In some instances side rot (*Sporotrichum malorum* Kidd and Beaum), gray mold (*Botrytis* sp.), bitter rot (*Glomerella cingulata* Ston., Spauld., and V. Schrenk.), or organisms causing other decays were present. In comparing the influence of temperature on the development of decay, it seemed logical to consider only those lots in which decay was found in appreciable amounts (at least 5 percent) at one or both temperatures. The results with the Wealthy variety were not included, because the growth cracks that were present on these apples made them particularly susceptible to decay. Likewise, results with the Jonathan variety in which special treatments, such as delayed storage, were used, were not included. Only the results of the inspection after the 7-day ripening period were used, as this was the more important inspection and included the decay present at time of removal as well as that developing during the afterripening.

With these restrictions there were 49 comparable lots from each of the 2 temperatures in which at least 5 percent of decay developed. Of these 49 lots 20 were from 1935, 22 from 1936, and 7 from 1937. They were distributed among the different varieties as follows: 2 each for Delicious and Golden Delicious; 3 each for Arkansas and Bonum; 4 each for Grimes Golden, Stayman Winesap, and Winesap; 5 each for Ben Davis, Rome Beauty, Jonathan, and Yellow Newtown; and 7 for York Imperial. In these lots there was an average of 13.6 percent decay at 32° F. and 19.8 percent decay at 36°. On this basis the decay averaged 45.6 percent greater at 36°. Although in a number of instances there was more decay at 32° than at 36°, a statistical analysis of the data indicated that this higher average decay at 36° was highly significant.

The average percentage of decay for all lots, and not just those that showed at least 5 percent, is shown in figure 1 for the various inspections. At all inspections the decay averaged higher at 36° than at 32°. It was 80 percent higher at 36° after 2 or 3 months' storage, 26 percent higher when held at 70° after 2 or 3 months' storage, and 55 percent higher when stored for 4 or 6 months, and 51 percent higher when held at 70° after this period of storage.

The results are in accord with those of other investigators (5, 10, 15, 17, 29).

## DEVELOPMENT OF SCALD IN RELATION TO STORAGE AT 32° AND 36° F.

As with decay, it seemed advisable in comparing the amount of scald at the two temperatures to consider only those lots in which at least 5 percent of the disorder was present at one or both temperatures. Although the apples were not always packed in oiled paper, considerable scald developed in many lots packed in oiled paper, as well as in those without it. There were 61 comparisons between 32° and 36° F. in which at least 5 percent of scald developed at one or both temperatures. Thirty-eight of these comparable lots were packed in oiled paper and 23 were not. This does not mean that more scald would occur with oiled paper than without, as more lots were stored with oiled paper than without it and there were no comparisons between comparable lots with and without the oiled paper. It does indicate, however, that oiled paper cannot be depended on to give complete control of scald. Scald was present in over twice as many lots of 1936 as in either 1935 or 1937. This is in accordance with general experience, as scald was found to be very prevalent in commercial cold-storage holdings in the Shenandoah-Cumberland region in the 1936 crop.

In many instances very little or no scald was found in lots when inspected at the time of removal from storage, but it became severe during afterripening at 70° F. Thus there were 18 comparisons in which appreciable scald was evident at the time the fruit was removed from storage and 43 comparisons after a week's exposure to 70°. The average scald present in the 18 lots at the time of removal was 12.5 percent for 32° and 21.1 percent for the storage at 36°. In the 43 comparisons after 7 days at 70°, there was 35.4 percent of scald for the 32° and 31.2 percent for the storage at 36°. The data indicate that scald was more severe at the time of removal following storage at 36°, but it developed with greater rapidity at room temperature after removal of apples from 32° storage, and showed greatest severity in such fruit after a week at 70°. However, because of the great variability in the amount of scald developing in the different lots, the differences between the amount of scald at the two temperatures was not found to be significant. Had the lots been replicated so that a more precise measure of the errors could have been determined, it seems likely that the differences might have been found to be significant.

The average percentage of scald in all lots, and not just those with at least 5 percent, is shown in figure 1. These results indicate that scald may not be very apparent during storage but increases greatly after removal of the fruit from storage to warm temperatures. Results on this basis also indicate that scald may be more severe during storage at 36° than at 32° F., but develops more rapidly after removal on lots from 32° storage.

These results are in accord with those of Magness and Burroughs (15) in which scald in some instances was more severe at 32° than at 35° F., but are not in accord with those of other investigators (4, 5, 10, 17, 26, 27, 29, 30) who have consistently found storage scald to be more severe or to develop more rapidly at the higher temperatures. The cause of this discrepancy is not apparent. However, in some of the previous studies on scald the inspections apparently were made

at the time the apples were removed from storage, and there is no indication that inspections were made after a period at room temperature. It is possible that a greater potential susceptibility to scald is developed at the lower temperature, but the development of the actual scald is retarded by the low temperature and develops rapidly on removal of the fruit to ripening temperatures. On the other hand, there may have been some factor other than temperature that has influenced the development of scald in these investigations. The 32° room was generally more completely filled with apples than the 36° room, and this might have resulted in a higher concentration at 32° of the volatile substances that cause scald.

#### DEVELOPMENT OF INTERNAL BREAK-DOWN IN RELATION TO STORAGE AT 32° AND 36° F.

As with decay and scald, it seemed advisable to consider only those lots in which at least 5 percent of internal break-down was present in apples from storage at one or both temperatures. This amount of break-down did not occur in Ben Davis, Golden Delicious, Yellow Newtown, or York Imperial varieties. Considerable break-down occurred in Jonathan, Stayman Winesap, Arkansas, Grimes Golden, and Rome Beauty apples. In the Arkansas and Stayman Winesap varieties break-down was consistently more severe at 36°, whereas in Jonathan, Grimes Golden, Rome Beauty, and Winesap there were often rather large differences, but they were not consistently higher at either temperature. The average of all lots (fig. 1) shows a greater percentage at 36° at all inspections.

#### SOFTENING AND RIPENING OF APPLES AT 32° AND 36° F.

In agreement with the findings of Magness et al. (16) and other workers, these results indicated a faster rate of softening and ripening at 36° than at 32° F. There is a tendency for the rate of softening to slow down after reaching a fairly low point (depending on the variety). Consequently the firmness at 32° may eventually become about the same as at 36° storage. Under these conditions, there was often a difference in ripeness with little or no difference in firmness.

The average firmness and ripeness of all lots is shown in figure 2. The storage periods shown correspond with those in figure 1. The average difference in firmness at 32° and 36° F. ranged from 1.8 to 0.7 pounds, being greatest after the short storage period and least after ripening at 70°. The average ripeness was determined by giving numerical values to the different degrees of ripeness, with hard rated as 5.0, firm as 4.0, firm ripe as 3.0, ripe as 2.0, and overripe as 1.0. Intermediate degrees of ripeness were given fractional numbers. For example a lot rated hard to firm would be given a value of 4.5. The results in figure 2 indicate a rate of ripening at the two temperatures corresponding to the softening rates. Thus, at three inspections the average firmness of the lots was 12.4 pounds, and the ripeness in all of these instances average 2.6 or about firm ripe to ripe.

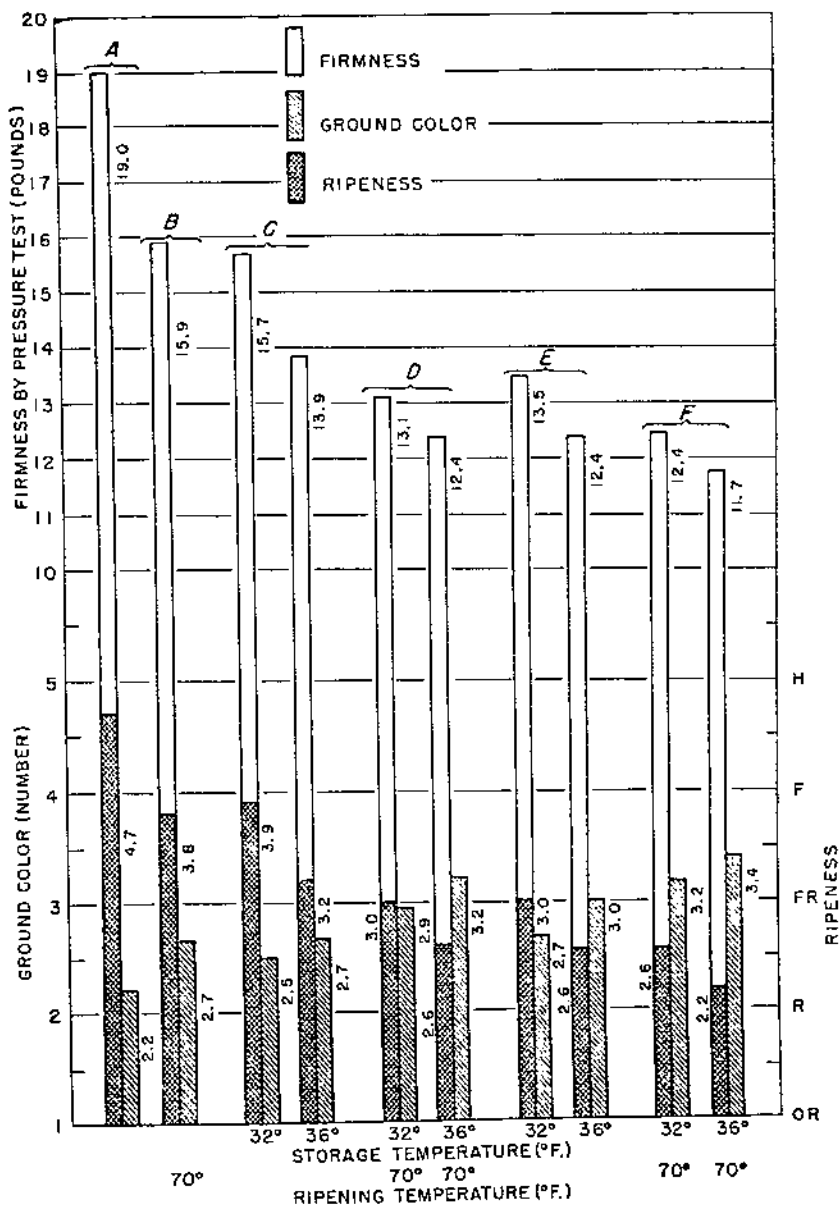


FIGURE 2.—Effect of storage at 32° and at 36° F. on firmness, ripeness, and ground color of apples: A, Before storage; B, ripened immediately (5 to 10 days, generally 7) at 70°; C, after 2 or 3 months' storage; D, ripened (7 days) at 70° after 2 or 3 months' storage; E, after 4 and 6 months' storage; F, ripened (7 days) at 70° after 4 and 6 months' storage. In ripeness, H (hard) is rated as +5.0; F (firm), +4.0; FR (firm ripe), +3.0; R (ripe), +2.0; and OR (over-ripe), +1.0. In ground color, 1 represents green and 4 represents yellow.

## DEVELOPMENT OF GROUND COLOR AT 32° AND 36° F.

As would be expected from the faster ripening at 36° F., there was also a more rapid change in ground color at 36° than at 32°. With many of the varieties the average difference was not statistically significant and with others the difference was too small to be of practical importance. The greatest average differences were found in the Rome Beauty and Bonum varieties, in which the differences averaged about 0.50 of a color unit on the color chart used. Grimes Golden, Golden Delicious, Jonathan, Yellow Newtown, and Stayman Winesap averaged between 0.18 and 0.30 difference in ground color and the other six varieties 0.12 or less. There was no indication of lack of ability to develop yellow color in these varieties after storage, as there were changes in ground color during afterripening at 70° in the last lots to be removed from storage (fig. 2).

## DESSERT QUALITY OF APPLES STORED AT 32° AND 36° F.

Dessert quality is a combination of taste, aroma, texture, and juiciness of the fruit. There is no precise measure of dessert quality, and its estimation is open to considerable error due to personal judgment or standards. The results, however, indicate a gradual deterioration in dessert quality during storage. As with ripening and other changes this deterioration appears to be more rapid at 36° than at 32° F. In a few instances the quality was somewhat better at 36° on the first inspection. This was generally due to insufficient ripening at 32° for the fruit to be in prime edible condition. In many instances there was no appreciable difference in quality, but particularly in the late inspections there was frequently distinctly better quality in the apples from 32° storage. This is not in accord with the reports of Plagge, Maney, and Pickett (24, 27) but is in agreement with the findings of Powell and Fulton (29), Magness and Burroughs (15), Tiller and Chittendon (35), and Smith (32).

## DISCUSSION

Storage at 35° to 36° F. instead of at 31° to 32° has been recommended by Plagge, Maney, and Pickett (27, 28), because certain low-temperature disorders may be largely controlled and better ground color and dessert quality may be obtained at the higher temperatures. These authors further maintain that scald, which was found to be more severe at 36°, could be very largely controlled by picking the fruit at proper maturity and storing with oiled paper. They also state that with present methods of spraying and handling, only sound fruit (free from skin breaks) need be stored and consequently decay will not be a factor.

In the investigations reported herein, on the contrary, low-temperature injury, such as soggy break-down and soft scald, was not a factor and occurred only on Jonathan apples that were delayed at room temperature (65° and 70° F.) previous to storage. Even in these lots the greater amount of soft scald at 32° was largely counterbalanced by the greater amount of other disorders, such as Jonathan spot, at 36°. Furthermore, apples of this variety that have been delayed for



any appreciable time at room temperatures become so ripe as to be hardly suitable for storage.

On the other hand, considerable scald developed in many of the experimental lots even though the apples were picked during the commercial harvest season and packed in oiled paper. Apples of the 1936 crop in the Shenandoah-Cumberland region were particularly susceptible to scald, and much scald was observed in commercial lots during that storage season.

Although these results indicate little or no difference in the development of scald at 32° and at 36° F., other investigators have found that scald increased with temperature and was greater at 36° than at 32°. Thus storage at 32° would be desirable for the control of this disorder.

Brooks, Cooley, and Fisher (5) found that scald increased with temperature up to 68° F. In the results reported herein no scald was found at 70° when the apples were held at this temperature immediately after harvest.

Baker and Heald (1) have shown that lenticel infection is one of the important causes of loss from blue mold in lots in which small percentages of decay (1 to 3 percent) occur, and that it, rather than mechanical injury, is responsible for much of the development of blue mold decay showing in stored fruit. Where black rot was present in the investigations reported herein the center of infection was generally in the calyx and not at a skin break. Bitter rot also apparently may gain entrance into the apple through the unbroken skin, and the infections frequently occur in the orchard before the fruit is handled. Likewise gray mold is apparently able to enter sound fruit. Side rot generally centers around lenticels. Thus, although careful handling to prevent skin breaks would tend to reduce the amount of decay, it would not control it, because organisms that are responsible for practically all of the rot of apples in storage may gain entrance through the unbroken skin. This is contrary to the contention of Plagge, Maney, and Pickett (27) that decay need not be a factor if the fruit is handled so that bruising and skin breaks are avoided.

In commercial storage where large blocks of fruit may be stacked close together the temperature of the fruit may be 2° to 4° F. higher near the center of the stacks than is the temperature of the air in the aisles. Consequently, if a storage temperature of 36° is used, it is likely that many apples will be held at fruit temperatures of 38° to 40°, particularly during the early part of the storage period.

These investigations have shown certain material advantages in storing apples at 32° F. rather than at 36°. The principal advantage of storage at 36° has been in the control of soggy break-down and soft scald. Brooks and Harley (6) and Brooks and McColloch<sup>4</sup> have shown that several prestorage treatments will also control these disorders. They state that accumulated soft scald tendencies have been largely removed by coating the fruit with a mixture of oil and paraffin or by short-period prestorage exposure to partial vacuum, to high temperature (95° to 110° F.), or to carbon dioxide gas, and that accumulated soggy break-down tendencies have made a similar response to carbon dioxide treatments. Furthermore, the carbon dioxide treatments had a beneficial effect upon firmness. With fruit that is thought to be susceptible to soft scald or soggy break-down

<sup>4</sup> Unpublished results.

it would seem advisable to control these disorders by prestorage treatments with carbon dioxide and then storage at 32°. If such treatment is not feasible it may be desirable to store such fruit at 36° if the storage is not to be for an extended period. Likewise, Yellow Newtown apples when grown under conditions that make them susceptible to internal browning should be stored at 36° to 38°, as previously recommended (2, 18).

### SUMMARY AND CONCLUSIONS

Results are presented showing the response of 13 varieties of apples (Arkansas, Ben Davis, Bonum, Delicious, Golden Delicious, Grimes Golden, Jonathan, Rome Beauty, Stayman Winesap, Wealthy, Winesap, Yellow Newtown, and York Imperial) to storage at 32° and 36° F. during three seasons.

The average percentage of decay in lots that developed appreciable amounts after ripened was nearly 50 percent greater following storage at 36° than at 32°.

There was some indication that scald appeared earlier at 36° but eventually became equally as or more severe after storage at 32°.

In the Arkansas and Stayman Winesap varieties internal breakdown was more severe at 36°. In the other varieties there was no consistent difference in relation between amounts of break down in the two storage temperatures.

Softening and ripening of the apples was generally much more rapid at 36° than at 32°.

There was a more rapid change in ground color from green toward yellow at 36° than at 32°. The difference in ground color was largely due to difference in ripeness of the apples from the two temperatures, and with most varieties it was not sufficient to be of practical significance.

There was a gradual deterioration in dessert quality during storage. This was generally more rapid at 36° than at 32°. With short periods of storage the difference in quality was slight or imperceptible, and in a few instances the dessert quality was better at 36° because of the unripe condition of apples from 32° storage.

Individual varieties varied somewhat in their response to temperature. With nearly all of the varieties studied, 32° was preferable for long periods of storage. In some instances either 32° or 36° was satisfactory for relatively short periods of storage. Of the varieties studied, only Grimes Golden gave with fair constancy better results when stored at 36°.

On the basis of these results and in consideration of the reports of other workers, there appears to be no sound reason for changing the recommendation that, in general, apples be stored at 31° to 32° F.

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