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## Picking Maturity of Apples<sup>1</sup>

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### NEED FOR AND RELIABILITY OF INDEXES OF MATURITY

The dessert quality, storage capacity, and commercial value of apples are influenced greatly by the maturity at which the fruit is picked. If picked prematurely, apples are likely to be small, tough, poorly colored, sour, off flavor, and subject to scald in storage. If picked when overmature, they are likely to have developed water core while still on the tree; with some varieties the red color may become too dark and dull and the skin may become greasy or oily. Overmature apples are likely to become mealy or to break down after storage and to be flat in flavor. Generally there is a period of 5 to 20 days, depending on variety and cultural and climatic conditions, during which the fruit can be picked with the assurance that it will remain reasonably free of the storage disorders associated with immaturity or overmaturity and will ripen with reasonably good dessert quality. It is obviously

<sup>1</sup> This circular supersedes Department Bulletin 1448, Picking Maturity of Apples in Relation to Storage (13).

important that means be devised for determining the beginning and duration of this period, so that apples may be picked during this period as far as practicable.

Many factors determine the best time to harvest an apple crop. Each variety presents an individual problem. The importance of the factors involved in establishing indexes of maturity will depend on the variety but may vary within a variety, with different cultural and climatic conditions. In the case of all varieties, however, the fruit increases in size as long as it remains attached to the tree.

From this standpoint it is desirable to leave the fruit on the tree as long as dropping does not equal or exceed the volume increase. However, picking should be completed by the time the loss due to dropping equals the gain due to volume increase. Since the time when dropping is likely to become excessive cannot be predicted, picking should start while the fruit is still adhering well.

It has been suggested that the time at which apples should be picked may be determined by the ease with which fruit can be separated from the spurs and the extent to which sound fruit is dropping. However, under certain conditions the apples may start to drop before satisfactory maturity from the standpoint of dessert and storage qualities has been reached. As indicated, the tendency to drop is not a satisfactory index of when to start picking; for once dropping has started it is likely to become excessive before picking can be completed and the change in ease of separation of the fruit from the spurs previous to dropping is not sufficiently marked or distinct to be taken as a picking guide.

The amount of red color on red varieties, which increases during the harvest period, is an important factor in the commercial value of the crop. It is desirable to leave the apples on the tree until sufficient red has developed. However, with some varieties and conditions the fruit may become overmature before it becomes well colored. On the other hand, apples of some of the red bud sports may become well colored while still immature.

The change in the ground color from green to yellow is desirable, particularly with yellow varieties such as Golden Delicious and Grimes Golden. This change has also been suggested as an index of picking maturity. With many varieties there is no appreciable change in the green color at the approach of maturity, and with others the changes are not sufficiently marked or consistent to be of much value.

There is a gradual softening of the fruit on the tree previous to and during the harvest period. This change is useful as an indication that the fruit is becoming too soft for good storage quality.

Changes in horticultural practice and recent investigations<sup>2</sup> have shown the need for some changes in the recommendations made in

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<sup>2</sup> In a cooperative investigation between the Bureau of Plant Industry, Soils, and Agricultural Engineering and various State agricultural experiment stations, data relative to the elapsed time from bloom to maturity have been obtained in different apple-producing districts as follows: For Virginia, Maryland, and West Virginia by Mark H. Haller, Bureau of Plant Industry, Soils, and Agricultural Engineering; for Washington by Edwin Smith, Bureau of Plant Industry, Soils, and Agricultural Engineering; for Illinois by Richard V. Lott, Illinois Agricultural Experiment Station; for Ohio by C. W. Ellenwood, Ohio Agricultural Experiment Station; for Michigan by Roy E. Marshall, Michigan Agricultural Experiment Station; for New York by Henry O. Bennett, Bureau of Plant Industry, Soils, and Agricultural Engineering; and for Oregon by Gordon Brown, Oregon Agricultural Experiment Station. A preliminary report (8) has been made of some of the data for Virginia, West Virginia, and Maryland. The more recent data have not been published but have been used as a basis for making recommendations relative to the number of days from bloom to maturity in this circular. Such recommendations are based on the results of these cooperative studies except when other references are cited.

1926 (13)<sup>3</sup> relative to methods of determining picking maturity. The elapsed time from full bloom to maturity has been found to be rather constant for a number of varieties and constitutes the most reliable index of the earliest maturity date.

## DEFINITIONS OF MATURITY TERMS

As an apple develops on the tree it passes through several stages of maturity from immature to overmature. The stage of maturity at which an apple is picked is reflected in its subsequent storage and dessert qualities. Reference is made in this circular to several stages of maturity as follows:

**IMMATURE.**—Apples picked when immature will soften somewhat and may turn yellow when ripened; but the flesh is likely to be tough, the taste sour, the flavor lacking or undesirable, or the storage quality poor because of susceptibility to storage scald, bitter pit, or other disorders associated with immaturity.

**EARLY MATURITY.**—Apples picked at this stage ripen with only fair dessert quality for the variety but will be reasonably free of disorders associated with immaturity during storage. Earliest maturity is the beginning of this period.

**OPTIMUM MATURITY.**—Apples picked at optimum maturity can be stored with a minimum of storage disorders and ripened with maximum dessert quality for the variety and conditions of growth.

**LATE MATURITY.**—Apples picked at this stage are still satisfactory for picking, but they will be somewhat flat in flavor and may show a slight tendency to become mealy and to develop disorders associated with overmaturity.

**OVERMATURITY.**—When allowed to remain on the tree until overmature, the fruit may ripen quickly to a mealy condition, may be flat in taste, or may be subject to internal break-down or decay during storage.

An apple is mature and satisfactory for picking during the period from earliest maturity until overmaturity is reached.

The changes in the fruit on the tree that result in differences in its storage and dessert qualities are gradual, so that it is possible only to approximate the time at which a given stage of maturity is reached. This is particularly true of varieties in which maturity is based primarily on the dessert quality of the ripened fruit. Although good storage and dessert qualities are usually rather closely associated, they do not always coincide and apples may attain satisfactory maturity from the standpoint of storage quality earlier or later than they attain satisfactory maturity from the standpoint of dessert quality. This also complicates the exact establishment of a given stage of maturity.

## ORCHARD AND STORAGE DISORDERS RELATED TO MATURITY

There is a direct association between various physiological disorders of apples (6) and their degree of maturity when picked. Of these, bitter pit and storage scald are associated with immaturity, whereas Jonathan spot, soggy break-down, water core, and internal break-down are associated with overmaturity.

The most serious of these disorders is storage scald (6), a surface browning or blackening that develops in 60 to 90 days after harvest in such early ripening varieties as Grimes Golden and in 100 to 150 days with later kinds. It is more serious in cold storage than in common storage. The unblushed parts of the fruits are most affected, and

<sup>3</sup> Italic numbers in parentheses refer to Literature Cited, p. 23.

immature apples are more susceptible than those picked later. Picking the fruit at proper maturity helps to prevent scald. Shredded oiled paper or oiled-paper wraps are used to control scald, but neither of these will prevent it in immature fruit of susceptible varieties.

Bitter pit (6), also called stippen, Baldwin spot, and York spot, occurs as brown spongy or corky spots in the flesh usually just under the skin and frequently causes depressions in the surface of the fruit. It seems to develop most in storage on apples picked before they reach proper maturity. It is particularly prevalent on Baldwin, Gravenstein, Arkansas (Mammoth Black Twig), Delicious, Yellow Newtown, Rhode Island Greening, and Northern Spy. Bitter pit also develops in fruit still attached to the tree, but probably to a less extent than in fruit harvested early and placed in storage. Also much of the fruit affected with bitter pit can be sorted out when mature fruit is packed.

Water core (2, 6), a functional disease that gives the flesh a water-soaked appearance, develops under favorable conditions as apples reach maturity; when it is present it may cause growers to pick the fruit of some varieties earlier than otherwise desirable. A small amount of water core at picking time, particularly in the slower softening, longer keeping varieties such as Winesap and Yellow Newtown, will often disappear in storage, and the quality will not be lowered. This disorder seriously affects the quality of rapidly ripening varieties such as Jonathan and Delicious, in which it is likely to lead to internal break-down.

Internal break-down is a senility disease that is characterized by brownish discoloration of the flesh, development of mealiness, and loss of flavor (6). It is associated with apples that were overmature or water-cored when picked or that have been held in storage too long.

Soggy break-down (6, 17, 18) is a low-temperature disorder that occasionally occurs in Grimes Golden, Wealthy, Golden Delicious, and a few other varieties. Soggy break-down is distinguished from internal break-down in that in the former there is a sharp demarcation between the sound and affected tissues and the affected tissue is wet or soggy rather than dry and mealy. It is generally more severe in late-picked apples, particularly if they are kept for a period at room temperature before cold storage.

Soft scald (6, 18) is also a low-temperature disorder to which Jonathan is particularly susceptible; occasionally it also occurs on Northwestern Greening, Rome Beauty, Wealthy, Golden Delicious, Winesap, and McIntosh. It is distinguished from storage scald in that the affected parts are more sunken and soft and occur in definite patterns with a sharp demarcation between the affected and sound tissues. Oiled paper, used to control storage scald, is ineffective for soft scald. Although the severity of soft scald varies with different maturities, its exact relation to maturity is not clear. Under some conditions it may be more severe in early-picked apples and under others in intermediate- or late-picked (18).

Jonathan spot is a superficial skin disease characterized by small, black or brown spots, resembling freckles, that occurs on Jonathan, King David, and Rome Beauty apples when they are left on the tree until they approach overmaturity.

# CHANGES IN APPLES APPROACHING PICKING MATURITY

## INCREASE IN SIZE

Previous studies (12, 14) have shown that as long as apples hold on the tree growth in size continues. The rate of increase depends on the availability to the fruit of elaborated foods and moisture. Spray or other injury to the leaves, low temperatures, water shortage, senility of the leaves, and any other factors that decrease the photosynthetic activity of the leaves reduce the growth rate of the fruit. Fruits of summer varieties such as Yellow Transparent and Williams are growing rapidly as they approach maturity and may increase as much as 2 percent per day in volume during the harvest period. Fruits of early-fall varieties such as Jonathan and Grimes Golden normally average about 1-percent increase per day during the harvest period whereas those of late varieties such as Winesap that mature during the cool weather may not increase more than 0.5 percent per day. Under conditions favorable to growth, delaying the picking of the crop will result in larger fruit and an appreciable increase in crop volume. From 0.5 to 1 percent of the fruit must drop daily before the total tonnage will be materially reduced below that from an earlier picking.

## CHANGE IN SEED COLOR

The browning of the seeds in apples as they approach picking maturity has often been suggested as an index of the best time for picking the fruit. The seeds of winter apples, however, usually become brown a considerable period prior to the optimum picking date. The time of the coloring of the seeds varies so greatly with variety and season that this change is of little value in determining when to pick the fruit. It may be stated, however, that winter apples are practically never ready to pick before the seeds have reached a full brown color.

## CHANGES IN CHEMICAL COMPOSITION

There are a number of changes in the chemical composition of apples as they approach picking maturity, but the extent of these changes is not great and the rate of change is not rapid. In general, as the fruit matures on the tree the astringent substances, including tannin, tend to decrease, the acidity decreases, and the sugar content increases. Many studies have been made to develop chemical tests for picking maturity, similar to the sugar and acid tests used on citrus fruits and grapes. Because of the wide variations in the chemical composition of apples caused by factors other than ripening, however, a chemical test for time of picking appears to be of little practical value. The percentage of sugar varies with the quantity of fruit on the tree, the moisture supply, and the climatic conditions, as well as with the degree of maturity. The sugar content of fruit from heavily loaded trees is below that of fruit from lightly loaded ones under similar growing conditions and in a similar stage of maturity (10). The work of Caldwell (3) indicates that the sugar content of apples is higher in seasons of high sunlight than in those of low sunlight. The changes

in chemical composition due to variations in growing conditions are so great that any picking test based on chemical composition has proved unsatisfactory.

Many tests have been made to determine whether the disappearance of starch (determined by the iodine test) is an indication of maturity. There is a gradual conversion of starch to sugar as the fruit matures, but some varieties become mature before any appreciable change occurs in the starch test. Some starch always remains when the fruit is in the best condition for picking, but the extent of the conversion at maturity may vary with different climatic and cultural conditions. Thus, as with other chemical tests, those based on starch disappearance have but limited value in determining stage of maturity of apples.

### CORKING OVER OF LENTICELS

The lenticels, or pores in the skin, which in the immature fruit open more or less directly to the flesh tissue below, become filled with cork cells and sealed partially or wholly as the fruit approaches maturity on the tree. The waxy coating also develops on the surface of the fruit during the latter part of the growing season. The development of the heavy wax coating and the sealing of the lenticels make the fruit that is well matured at picking time somewhat more resistant to wilting in storage than that picked in an immature condition. These changes, however, are not sufficiently discernible to make them of much value in determining when the fruit should be picked.

### CHANGE IN FRUIT COLOR

The change in color of apples as they mature on the tree is twofold. One is the development of red in blushed or colored varieties, while the other is the change in the unblushed portions. The green ground color of the immature fruit changes first to greenish yellow and finally to an almost full yellow as the fruit matures.

The development of the red color is a very important factor in determining when to pick apples for commercial purposes, since high color is essential to the advantageous marketing of many varieties. The development of red depends very largely, however, upon the exposure of individual fruits to sunlight and upon the prevalence of bright, sunny days during the maturing season. The sugar content of the fruit also appears to be an important factor in color development. Except in the early coloring sport strains, the development of a good red color is usually indicative of maturity. However, because of the variability in color development associated with weather conditions, fertilizer practices, and other factors, red development is not a fully dependable criterion of maturity. Some fruit may be mature before it is well colored, whereas other fruit, particularly that of colored strains, may be colored before it is mature.

Light exposure has little to do with the disappearance of the green ground color in the unblushed parts of apples, and in some varieties this disappearance is a supplemental index of maturity. In the red bud sports of some varieties the red frequently covers the surface so completely and so early that the ground color cannot be observed.



In other varieties the ground color does not change appreciably as the fruit becomes mature. With such varieties the ground color cannot be used to indicate maturity; neither can it be used for this purpose with fruit on trees highly fertilized with nitrogen, as such fruit tends to retain the green color even when mature.

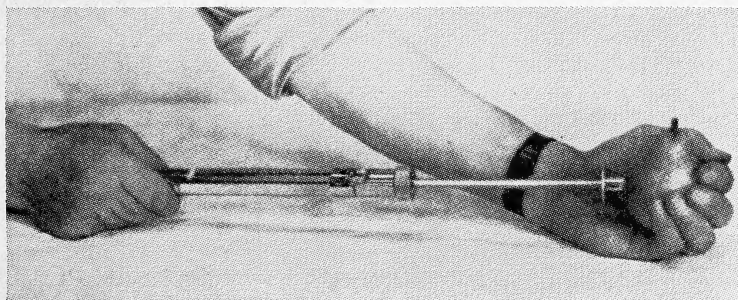
A color chart has been devised for use in determining the change in the ground color of apples from green to yellow. This consists of four colors from green (No. 1) to yellow (No. 4), closely approximating the color stages through which apples pass as they mature and ripen. A copy of this color chart may be obtained by writing the Plant Industry Station, Beltsville, Md. The ground color of the fruit is determined by matching the fruit color with one of the colors on the chart. This is done by placing the fruit back of the chart and fitting the unblushed portion into holes cut in the different colors. This should be done in diffused daylight (not in direct sunlight). When the color falls between two standard colors it may be described by a number; for example a color between No. 3 and No. 4 may be designated 3.5.

### SOFTENING

Under certain growing conditions and with some varieties, softening of the flesh of the apple has been used as an indication of maturity. Usually the fruit gradually softens as it approaches maturity on the tree. The firmness at maturity varies considerably from season to season and with growing conditions so that a precise degree of firmness at which an apple becomes mature cannot be given. However, if the fruit becomes too soft on the tree it may not hold up well in storage. The principal value of firmness measurements is to indicate when the fruit is becoming too soft or overmature, particularly with varieties that soften rapidly in storage and tend to develop mealiness or a mealy break-down.

The firmness of the flesh of the fruit can be most accurately measured by the use of a pressure-test apparatus. Such an apparatus with methods for its use has been described in previous publications (7, 15) and is now available on the market. It measures in pounds the pressure required to force a plunger seven-sixteenths of an inch in diameter into the apple to a depth of five-sixteenths of an inch, the skin being removed prior to making the test. Figure 1

FIGURE 1.—Fruit pressure tester for apples, pears, and peaches, showing method of use. (Photograph through courtesy of R. Schneider.)



illustrates the method of making the test. The fruit to be tested may be placed against any convenient solid surface, such as a wall or the trunk of a tree, if the test is being made in an orchard. The plunger tip is placed in contact with the cut surface and pressure is applied. When the plunger tip has penetrated to a depth of five-sixteenths of an inch, as shown by a line on the plunger tip, the pressure in pounds required to force the plunger into the fruit to this depth is read directly on the scale. In order to obtain a satisfactory indication of the condition of any variety, at least 10 to 20 apples selected from different trees and different parts of the trees should be used. Two or more tests may be made on each apple and the results averaged. Tests should be made within a few hours after picking. Values reported herein as firmness ranges for different varieties are based on tests made as described with the peel removed prior to testing. The application of pressure-test determinations to maturity and ripeness of fruits has been discussed in a recent publication (7).

### LOOSENING OF FRUIT FROM SPURS

As apples approach proper picking condition they generally tend to loosen from the spur so that when the fruit is lifted the stem readily separates. However, under certain growing conditions the fruits of some varieties such as McIntosh and Delicious may loosen and release easily before they reach satisfactory maturity. Early frosts also may cause fruit to loosen and drop before it is mature. On the other hand, fruits of certain varieties such as Jonathan and Stayman Winesap may adhere tightly until the fruit becomes overmature. Ease of separation of fruit from spurs, therefore, is not necessarily an indication of proper maturity, but it may indicate when picking is necessary to save the crop. In recent years harvest sprays of certain growth-modifying chemicals such as  $\alpha$ -naphthaleneacetic acid (1) have been used extensively for the prevention of fruit dropping, making unnecessary the premature picking of fruit that shows a tendency to drop early.

The ease with which fruit may be loosened from the spurs has become even less reliable as an index of picking maturity since the adoption of sprays for the control of harvest drop. The use of these sprays has made the maturity problem more complex because after their use fruit may be permitted to remain unharvested until it becomes overmature.

The tenacity with which the fruit adheres to the tree can be estimated only in a general way. If the stem of a sound fruit separates from the spur when the fruit is lifted or is given a slight twist, it would be considered that the fruit is loosening on the tree and separates easily. Under this condition it is probable that a small amount of sound fruit may be dropping. If no fruit is dropping and if the fruit can be picked only with considerable effort, it is considered that the fruit is still firmly attached to the tree. The dropping of wormy or otherwise injured fruit is not an indication of picking maturity.

### DEVELOPMENT OF WATER CORE

The development of water core in the fruit is a very important consideration in determining when to pick certain varieties. Investigations by Brooks and Fisher (2) have shown that water core usually

develops first in fruit exposed to the direct sunshine on the south and west sides of the trees. Consequently, apples from the exposed south or west and top parts of the tree should be examined for water core. If water core is not found or if it is present in only a slight degree in fruit from these positions on the tree, it is improbable that it will be present to an injurious extent in fruit from more protected parts of the tree.

## ELAPSED TIME FROM FULL BLOOM TO PICKING MATURITY

Magness et al. (14) and Palmer (16) observed that the number of days from full bloom to maturity was rather constant for a given variety even when grown under widely different climatic and cultural conditions. Further investigations of the reliability of this factor as a means of predicting apple maturity have been conducted in recent years (8).<sup>4</sup> The results confirm the earlier observation that the number of days from full bloom to picking maturity is rather constant over a wide range of climatic and cultural conditions and that this constitutes a more reliable index of maturity than any other single factor that has been suggested. Thus, the Delicious variety requires 145 to 150 days from bloom to reach acceptable picking maturity, and this has been found under widely varying climatic, soil, and cultural conditions of Washington, Oregon, Illinois, Ohio, Michigan, New York, and Maryland. It has not been possible to establish any influence of temperatures prevailing during the growing season on the elapsed time from bloom to maturity of apples although it may be a factor with other fruits. However, there have been some variations in elapsed time and certain factors undoubtedly influence this variation. Heavy nitrogen fertilization, for example, results in delayed color development of fruit and may result in greater scald development unless picking is postponed. On the other hand, dropping may be more pronounced from heavily fertilized trees than from trees not heavily fertilized. Because fruit from nitrogen-fertilized trees is likely to show poorer color and to be more susceptible to scald, it is usually desirable to postpone the time of picking such fertilized trees if the fruit is holding well enough to permit it, and thus to increase the time interval from full bloom to maturity. Similarly, a very light crop of fruit is likely to mature earlier than a heavy one. The extent to which these or other factors may retard or advance maturity has not been fully established.

The date of full bloom has been taken as the date when the first petals fall. Theoretically the date of full bloom should be the time of pollination or fertilization in the blossoms that set the fruit. During some seasons warm weather brings out all the blossoms in a very few days so that the time of full bloom can be readily established and is nearly the same for all blossoms. During other seasons, however, a period of warm weather may bring the center or king blossoms into full bloom and may be followed by cool weather that will retard the opening and pollination of the other blossoms for a week or more. Under such circumstances there is likely to be considerable error in establishing the date of full bloom applicable to most of the fruit that sets.

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<sup>4</sup> See footnote 2, p. 2.

The number of days from bloom to maturity for the varieties on which considerable information is available is shown in figure 2. The period of early maturity shown is either the period in which the fruit would be mature under conditions that would tend to hasten maturity, such as a light crop, or the early maturity for a more normal crop. The period of optimum maturity shown is the one when optimum maturity is most likely to occur; the period of late maturity shown is the period in which overmaturity or dropping may become imminent.

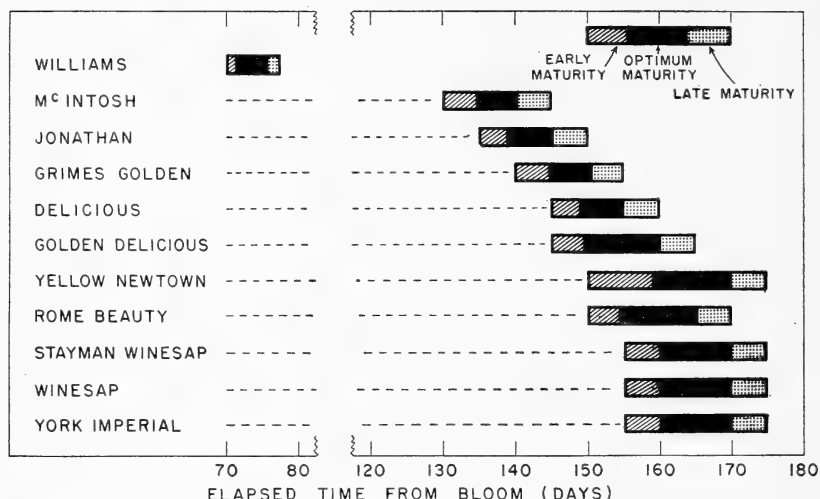


FIGURE 2.—Days elapsing from bloom to maturity for 11 varieties of apples. The period of early maturity shown is the period during which barely satisfactory maturity normally occurs, but optimum maturity may occur in this period under conditions that would tend to hasten maturity. Similarly, the period of late maturity shown is the period in which overmaturity or dropping may become imminent, but optimum maturity may extend into this period under conditions that retard maturity.

## PICKING TIME IN RELATION TO VARIETAL CHARACTERISTICS

Because of the wide variations even in the same variety of apple when grown under the climatic conditions prevailing in different parts of the United States and in the factors which determine optimum picking time for different varieties, it is difficult to discuss the relative value of different picking-time tests for apple varieties in general. The storage quality of certain varieties is greatly reduced by leaving the fruit on the tree too long, whereas with other varieties the greatest harm results from picking the fruit too early. It is believed best, therefore, to discuss the merits of the different tests for time of picking and the best time for picking different varieties in detail in connection with well-known commercial apples. The writers have set down in this circular information on the picking time of a number of varieties of apples which they have studied and on which they feel justified in making recommendations.

## ARKANSAS

The storage life of Arkansas (Mammoth Black Twig) apples is limited largely by the development of storage scald, but under some conditions this variety may be highly subject to decay and internal break-down also. It is usually hard at time of picking and softens rather slowly in storage, but it may become mealy and break down while still relatively firm. It requires a long growing season, usually over 160 days from bloom, to reach its best development on the tree. Since well-matured fruit is less subject to scald in storage, it is essential that this variety not be picked too early. However, since there is some danger also of its becoming overmature and subject to decay and break-down, picking should not be delayed too long after the fruit is ready for picking. When it is to be held in cold storage, fruit will be larger and of better color and will show less tendency to scald if it is picked relatively late. If it is to be held in common or air-cooled storage, fruit picked late will have greater firmness during the storage season. Apples of this variety, in common with those of most late-ripening apples, soften faster after being picked and while being held at the temperature prevailing in air-cooled storage than while attached to the tree. Thus, the later the fruit is picked the firmer it will be.

Arkansas apples probably should be picked between 160 and 175 days from bloom, but the exact interval from bloom to maturity has not been well established. When a harvest spray is not used the tendency for the apples to drop will help the grower to regulate the time of picking. Ground color at maturity will range from No. 2 to No. 2.5 of the color chart.

### ARKANSAS BLACK

Arkansas Black is a very firm variety, softening very slowly in storage. It is one of the hardest of the commercial varieties, usually testing near 25 pounds when in picking condition.

Arkansas Black colors very highly and has only a slight tendency to develop storage scald. There is little danger of its becoming so ripe on the tree that the storage quality will be injured. The fruit should be a full deep red when picked and should separate readily from the spurs. Fruit of this variety that is to be held in common storage should be picked as late as possible but before water core becomes serious, since it will ripen less while attached to the tree than while held in storage at the prevailing temperatures; the tendency to drop and to develop water core, or the possible imminence of severe freezing weather will determine when the fruit should be picked. For cold-storage holding it may be picked when fully colored.

### BALDWIN

In the southern apple-growing areas the picking period for Baldwin usually falls in September, whereas in the north-central and northeastern apple-growing regions where Baldwin is mainly grown it blooms much later and the harvest normally falls in mid-October. Since this variety ripens during hot weather in the South, it must be handled in cold storage if an appreciable holding period is desired.

In the short-season regions with much later harvests and cooler falls, to which Baldwin is best adapted, it can be held very successfully until midwinter or later in common storage.

Baldwin tends to scald considerably in storage, particularly as grown in the South, and to develop bitter pit when grown in the North. Early picking would favor these disorders. It also has a marked tendency to drop as soon as the fruit reaches the best picking condition or in some cases before. This tendency to drop has largely determined the time of picking.

The number of days from bloom to harvest for Baldwin, recorded for a number of localities and seasons, varies greatly. The shortest periods have been recorded for New York with an average of 135 days for 4 seasons (19), but 145 days was recorded for 1 season.<sup>5</sup> The longest periods have been recorded in Ohio, with an average of 161 days for 30 seasons (4) and a range of 147 to 166 days. Other records (14) for only 1 or 2 seasons gave 136 and 146 days for Massachusetts, 142 and 160 days for Ohio, 138 days for Virginia, 145 days for New York, 145 days for Washington, and 136 and 155 days<sup>6</sup> for Michigan. In nearly all instances these figures were derived from the records of actual dates on which apples were harvested and did not include comparisons with earlier or later pickings to determine whether the harvest dates represented optimum maturity. Harvests made less than 140 days after bloom may have been necessitated by a tendency to premature dropping that could have been retarded by harvest sprays. On the other hand, in the more northern areas growers could not harvest their apples after an elapsed period after bloom of 160 days (reported for Ohio), as their growing seasons from bloom to severe freezing are generally not that long. On the basis of these results it seems likely that at least 140 days should elapse from bloom before picking of Baldwins starts and that a more nearly optimum time of picking would be between 145 and 155 days from bloom. Any tendency for apples to drop earlier than this should be controlled if possible with harvest sprays.

### BEN DAVIS

In the eastern half of the United States Ben Davis is grown commercially over an extremely wide range of climatic conditions from south to north. The condition of the fruit at picking time will vary somewhat in these different areas, particularly as to firmness of flesh.

Probably this variety is handled more extensively than any other in common storage. The fruit holds late on the tree and there is little dropping; consequently, it is usually well matured when picked and relatively little scald develops during storage. If picked in an immature condition, however, the variety often shows extremely severe scald development.

Usually from 155 to 160 days elapses between the blooming season and the time of picking Ben Davis. In the northeastern apple areas it is frequently the last variety picked, and in the more southern apple areas the normal picking season is in early October.

This variety should not be picked before the ground color reaches the almost full yellow condition shown in Nos. 3 and 4 of the color chart. The fruit should be highly colored, also. When this condi-

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<sup>5 6</sup> See footnote 2, p. 2.

tion is reached in the southern areas the pressure test will usually be 19 to 17 pounds, whereas in the more northern areas it will be 20 to 19 pounds.

In the southern areas fruit left on the tree until softer than a condition represented by a pressure test of about 17 pounds is relatively poor for storage. Fruit of this variety when picked in a more mature condition than this will become soft relatively early in cold storage and may show physiological break-down or a collapse of the flesh if held in common storage. In the northern apple-growing areas there is relatively little danger of Ben Davis being picked too late provided severe freezing weather is avoided.

### CORTLAND

The Cortland apple, developed from a cross of Ben Davis and McIntosh, closely resembles the McIntosh parent; but it is described as being somewhat later to mature and having a somewhat longer storage life. Results for 3 seasons in New York (19) indicate that Cortland was usually harvested at about the same number of days from bloom (128) as McIntosh. One season's results in New York, in which samples picked at different maturities were compared after storage, indicated that both Cortland and McIntosh should be picked somewhat later (about 135 days from bloom). Results for 10 seasons in Ohio (4) showed a still longer period from bloom to harvest (average, 144 days; range, 133 to 155), which was also considerably longer than the comparable average for McIntosh (129 days). From these results it seems likely that at least 130 days from bloom should elapse before the picking of Cortland is started. Optimum maturity probably occurs normally at about 135 days. Like McIntosh the Cortland variety is fairly soft and ripens rapidly at high temperatures. It is essential, therefore, that the fruit be picked before it becomes too soft (pressure test of less than 15 to 14 pounds) and that the fruit be placed under refrigeration promptly after harvest.

Cortland is exacting in its picking requirements, developing storage scald if picked too early and break-down and meakiness if picked too late. Because its fruit holds on the tree much better than that of McIntosh, there has been a tendency to delay picking until harvest of McIntosh is complete. This has resulted in some overmature and poor-keeping Cortland fruit.

### DELICIOUS

Delicious is grown over a wide range of climatic conditions. High development of red is extremely desirable in this variety; in order to obtain good color, therefore, it is sometimes left on the trees so long that the storage quality is injured. On the other hand, if picked when too immature Delicious is of extremely poor dessert quality.

Elapsed time from bloom is probably the most reliable means of establishing the earliest time for picking this variety. Considerable data relative to the number of days from bloom to earliest picking have been accumulated. Earlier studies (14) from Massachusetts, Michigan, Ohio, Virginia, and Washington indicated that from 134 to 153 (average, 140) days elapsed from bloom to optimum maturity. Results for Ohio (4) for 30 seasons showed an average of 153 days

(range, 141 to 163) from bloom to harvest. Results for 4 seasons in New York (19) showed an average of 132 days from bloom to harvest. Studies in Washington indicated that at least 145 days elapsed from bloom to harvest. Recent cooperative studies in which samples were picked at intervals and stored to establish proper picking maturity more definitely, indicated that at least 145 days, and preferably 150 days, should elapse between bloom and picking in Washington, Oregon, Illinois, Ohio, Michigan, New York, and Maryland. On the basis of these results it would seem that this variety normally requires at least 145 days to mature sufficiently to have fair quality and that harvest should be completed by not more than 155 to 160 days for satisfactory storage holding. Shorter periods indicated in some of the reports may have been due to early harvest in which actual maturity was not established by storage tests on several pickings.

Under long growing season conditions Delicious apples may become overmature. Relative firmness may be used as an indication of the approach of an overmature condition. The apples should be picked before the pressure test drops below 15 pounds or preferably 16 pounds. Delicious grown in districts with long growing seasons has a tendency to develop water core; such development is a further indication that the fruit should be removed from the tree. Another guide in determining the picking time is the fact that the flesh of Delicious apples in proper picking condition is yellowish.

This variety holds for a long season in a firm, crisp condition if moved at once after harvest into storage at 31° to 32° F. It softens and becomes mealy with extreme rapidity, however, when handled at higher temperatures; consequently, it is not well suited to handling in common storage and any delay between date of picking and placing fruit under refrigeration will greatly decrease the time the fruit will remain in good condition in cold storage.

Delicious is subject to storage scald when harvested at a stage of maturity suitable for fair, but not optimum, dessert quality. In Washington 150 to 155 days from bloom is considered necessary to reach a scald-free stage of maturity. Where the size of the crop and the physical facilities for packing and storage make it necessary to start harvesting at the earliest possible date, it is important that such fruit be not held for late storage. Even the use of oiled paper will not control storage scald on Delicious apples picked before they have passed the susceptible stage.

Red bud sports of Delicious, particularly Starking and to a lesser extent Richared, develop red color earlier than regular Delicious, and the tendency in commercial practice is to pick them earlier. Maturity investigations have shown (5), however, that these sports do not mature any earlier than the regular Delicious; therefore they should not be picked until at least 145 days from bloom.

#### GANO AND BLACK BEN

The picking-maturity characteristics of Gano and Black Ben are similar. Both varieties are susceptible to storage scald if picked in an immature condition. As a consequence, it is necessary that the fruit remain on the tree until it is practically full colored so that it may have the best storage quality. Fruit of these varieties takes on a very high color and generally can remain on the tree until it is almost



100 percent red. When apples of these varieties are in the best picking condition, the unblushed portions should be practically of the full color corresponding to Nos. 3 to 4 of the color chart.

In districts with long growing seasons, a pressure test of about 18 pounds will indicate when the fruit is in best storage condition. The fruit usually holds to the tree very well, but if it begins dropping before it reaches the color condition and the pressure test suggested it should be harvested or harvest sprays should be applied.

### GOLDEN DELICIOUS

Golden Delicious is not subject to scald in storage, but it has a tendency to wilt, particularly when picked in an immature condition or when extensively russeted. When picked while still fairly green it does not develop in cold storage the attractive golden yellow that adds greatly to the appearance of the fruit and it also lacks its fine characteristic flavor. Generally Golden Delicious apples can be picked over a fairly long period with satisfactory results. However, it is a rather soft variety and there is a possibility of its becoming too soft for good storage quality if picked late.

The quality of the fruit of Golden Delicious seems to be influenced by the size of the crop to a greater extent than with some of the other varieties. With a light crop the ground color of the fruit turns yellow sooner and satisfactory dessert quality may be obtained in fruit picked 7 to 10 days earlier than fruit of a heavy crop.

Golden Delicious varies with respect to the length of periods from bloom to maturity, possibly due in part to crop size. With a light crop it seems likely that satisfactory maturity may be obtained when picking starts as early as 145 days from bloom; in general, 150 days should elapse before picking starts. Optimum maturity probably occurs between 150 and 160 days. At earliest maturity the ground color should have changed to about No. 2.5 to No. 3 of the color chart and should be between No. 3 and No. 4 at optimum maturity. For best storage the firmness of the fruit should not drop below a pressure of 14 pounds.

### GRIMES GOLDEN

If picked in an immature condition, Grimes Golden tends to scald badly in storage even when packed with oiled paper. If picked while still having a marked green color and moved promptly to cold storage, this variety ripens in storage without attaining the golden-yellow color so desirable on the retail market. It is a fairly firm variety and could be left on the tree longer than ordinarily is done without becoming too soft for good storage quality. However, it tends to drop badly and for this reason generally should be picked before appreciable yellowing occurs (8, 11).

Rather extensive records (4, 8, 14)<sup>7</sup> for this variety indicate that Grimes Golden requires at least 140 days from bloom to reach satisfactory maturity. When picked at this time the fruit still will be green (corresponding to No. 1 to No. 1.5 on the color chart), but under some circumstances considerable dropping may occur. Optimum maturity is reached between 145 and 150 days from bloom. Even

<sup>7</sup> See footnote 2, p. 2.

when picked this late Grimes Golden fruit will be rather green (probably about No. 1.5 to No. 2 of the color chart) and a harvest spray will probably be necessary to prevent dropping.

Because of the likelihood of dropping and for other reasons, Grimes Golden generally is picked somewhat earlier than is desirable for obtaining the best storage and dessert qualities.

Storage of Grimes Golden at 36° F. rather than at 32° has been recommended because of its greater susceptibility at 32° to scald (9) and to soggy break-down (17). However, it has a relatively short commercial storage period, deteriorating in dessert quality rather rapidly during storage; this deterioration is more rapid at 36° than at 32° (9). If the fruit is not picked until 145 days from bloom it should be possible to control storage scald with oiled paper. Thus, storage at 32° to retard loss in flavor would be preferable to storage at 36° in districts where soggy break-down is not a factor.

### JONATHAN

Jonathan usually requires about 135 to 140 days from full bloom to early picking maturity (4, 8, 14, 19),<sup>s</sup> but under some conditions acceptable maturity may be reached in 130 days. Thus in the southern section and the Pacific Northwest it becomes a fall variety; in the short-season sections, such as Michigan and southern New England, it is excellent for winter storage, being fairly well adapted to holding even in air-cooled storage.

Jonathan, particularly as grown under long-season conditions, is a variety which must be picked in just the right condition if good marketability combined with good storage quality is to be obtained. It is desirable to leave the fruit on the tree long enough for it to develop a high degree of red and the characteristic spicy, aromatic flavor. After this condition is attained there is frequently a relatively short period before the fruit becomes overmature, and it may develop Jonathan spot and water core while still on the tree. Even when these conditions do not occur overmature fruit is likely to become overripe rather quickly in storage and to develop Jonathan spot, break-down, or both during storage, particularly if moving into cold storage is delayed. Under certain growing conditions Jonathan is also subject to soft scald during storage. The severity of the soft scald varies with the condition of the fruit at harvest, but its relation to maturity has not been entirely consistent. In general, it appears to be more severe on early to intermediate maturities.

Although the elapsed time from bloom to maturity has varied considerably under different conditions, it is probably the most reliable index of maturity. Jonathan generally requires at least 135 days from bloom to earliest maturity and in some sections possibly 140 days. Optimum maturity generally occurs between 140 and 145 days from bloom. Under some conditions, however, the fruit may be overmature before a period of 150 days has elapsed. The minimum period that should elapse from bloom to picking is 135 days. Picking may be delayed for further development of the red color provided the fruit is still firm and free from water core. The development of water core or the softening of the fruit to 15 pounds' pressure or less would indicate that the fruit should be picked promptly.

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<sup>s</sup> See footnote 2, p. 2.

## McINTOSH

McIntosh appears to be almost immune to storage scald; consequently it is not essential to leave the fruit on the tree until late in order to obtain good storage quality. As high color commands a premium, the variety should be left on the tree long enough to attain this color. McIntosh is not susceptible to water core. It has, however, a noticeable tendency to loosen and drop from the tree frequently even before prime picking maturity has been reached. This tendency can be overcome partially by applying harvest sprays for the prevention of dropping.

Data (4, 14, 19)<sup>9</sup> relative to the period elapsing from date of bloom to maturity of McIntosh are rather consistent. They indicate that the minimum period is about 130 days from bloom, with optimum maturity generally between 135 and 140 days from bloom. Within these limits picking may be determined by the development of red color and the firmness of the fruit. If the fruit is poorly colored, picking may be delayed provided the fruit is holding on the tree satisfactorily and the firmness does not drop below 15 to 14 pounds' pressure.

## NORTHERN SPY

Northern Spy, like the McIntosh, is not susceptible to storage scald, and in the northern districts where it is generally grown it does not usually develop water core. It is, however, susceptible to bitter pit and early picking should be avoided. Fruit of this variety usually holds to the tree well and so may be allowed to remain rather late in order to get the best color development.

In the districts where there are cool growing seasons, to which the Northern Spy is best adapted, the fruit may be handled in common storage with very good results. If fruit is to be held in common storage picking should be delayed as late as possible, since the fruit softens less and is less subject to bitter pit while on the tree than in storage at prevailing temperatures. Color and the marketability of the fruit are also improved by late picking. For cold storage the variety may be picked whenever the color is satisfactory.

If Northern Spy is picked while very soft, it is essential that it be handled carefully in order to avoid bruising. If the fruit is sufficiently mature to show a pressure test under 16 pounds, it is often very severely bruised. Limited results indicate that this variety requires 145 to 150 days from bloom to maturity.

## RHODE ISLAND GREENING

Rhode Island Greening scalds badly in storage, and the commercial cold-storage life of the variety is largely limited by this trouble.

As the variety is green and there is no incentive for leaving it on the tree in order to obtain color, it is generally picked relatively early in the districts where it is grown. Undoubtedly this variety is often picked in a somewhat more immature condition than is most suitable for storage, particularly considering its extreme susceptibility to storage scald when picked at an immature stage. It is now generally

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<sup>9</sup> See footnote 2, p. 2.

picked at a pressure test of 22 to 20 pounds. It appears likely that if left on the tree until testing 20 to 18 pounds the fruit would show much less tendency to scald in storage and it could still be held in cold storage until well into the spring before it becomes overripe. The variety softens rapidly at high temperatures and should be removed promptly to cold storage if a long storage season is desired. Limited tests indicate that Rhode Island Greening requires 135 to 145 days from bloom to maturity.

### ROME BEAUTY

Rome Beauty has a pronounced tendency to scald in storage, particularly if picked in a somewhat immature condition and when grown under the conditions of a moderately long growing season, to which this variety appears to be best adapted. The fruit tends to develop water core if left on the tree too long. Generally it holds on the tree fairly well, so that little dropping is probable until after the fruit has passed prime condition. Large size is extremely desirable in this variety, since the fruit is used extensively for baking. Late picking results in larger fruit that is less subject to scald than early picked fruit.

At least 150 to 155 days (4, 16)<sup>10</sup> should elapse from bloom before picking of this variety is started. Optimum maturity generally is reached between 155 and 165 days from bloom.

If best storage is desired the fruit should be picked when the ground color agrees with No. 2 to No. 3 of the color chart and the pressure test is not lower than 17 pounds. If the fruit is softer than this at the time of picking, it will ripen and become mealy relatively early.

This variety should be watched for the development of water core and should be picked before it becomes serious. A small amount of water core will apparently disappear while the fruit is in storage, and no serious results will follow; but if water core is severe it will result in an early break-down of the fruit.

Rome Beauty has a marked tendency to become mealy in storage and should be handled promptly and placed in cold storage quickly after picking if long holding is desired.

### STAYMAN WINESAP

Stayman Winesap scalds badly if picked in a somewhat immature condition. High color is very desirable in this variety. From the standpoint of both scald resistance and appearance of the fruit, therefore, relatively late picking is desirable. There is a tendency for water core to develop, however, if the variety remains on the tree too long and storage break-down is common in very mature fruit. In some seasons dropping may also be serious.

Generally this variety requires at least 155 days from bloom to earliest maturity and 160 to 170 days for optimum maturity (4).<sup>11</sup> For the best storage results it should not be left on the tree until the pressure test is below 15 pounds. Fruit testing between 18 and 15 pounds has been found very satisfactory for storage. In general it may be said that this variety can stay on the tree until the pressure test reaches 15

<sup>10 11</sup> See footnote 2, p. 2.

pounds or slightly less, without serious injury to the storage quality. If appreciable water core begins to develop the fruit should be picked.

Delayed picking is desirable to obtain high color, good size, and good dessert quality. The number of days from bloom is probably the most reliable index of time to start picking. The development of water core often indicates the approach of overmaturity.

Stayman Winesap ripens relatively rapidly after being removed from the tree; if long keeping is desired, therefore, the variety should be placed under refrigeration immediately, particularly if picking has been delayed until the fruit has become rather soft.

### WAGENER

The Wagener variety is extremely susceptible to water core while on the tree and to scald while in storage. In general, in order to insure high color and the greatest resistance to storage scald, the fruit should be left on the tree until it begins to drop or until water core begins to develop.

This variety is well adapted to a short period in air-cooled storage in the shorter season districts. If intended for common-storage holding, fruit should remain on the tree as long as possible or until water core development becomes serious. If intended for cold-storage holding, the fruit should be picked late or oiled paper should be used in storing it. If placed in cold storage after being packed in oiled paper, fruit showing a pressure test of 18 pounds or slightly above will apparently give very satisfactory results.

Palmer (16) pointed out that Wagener fruit requires a long growing season of 170 days from bloom to develop good dessert quality and resistance to scald and that it should not be grown in regions having short growing seasons. In the United States, however, the variety is most extensively planted in Michigan, and in that State it cannot be left on the trees as long as 170 days because freezing may occur about 160 days from bloom.

### WILLIAMS

The Williams variety blooms rather unevenly and also matures its fruit unevenly; usually several pickings, based on color and size of the fruit, are made. The apples generally mature in about 70 days from bloom (8). This brings them to maturity in midsummer, and they ripen very rapidly at summer temperatures. If stored at all, ordinarily they are held for only short periods. The fruit must be cooled promptly after harvest if it is to be held in storage. This variety drops badly when mature unless harvest sprays are used. Such sprays are extremely effective in preventing dropping of Williams. If these sprays are used, care must be taken not to allow the fruit to become overmature on the trees or it will break down badly while on the market.

### WINESAP

When picked early, Winesap has a rather pronounced tendency to scald late in the storage season. Moreover, it is of great advantage to leave the apples on the tree sufficiently long to acquire maximum size and the characteristic high color of the variety. Winesap apples

generally tend to be smaller than is desired in the domestic markets; it is important, therefore, that the season of growth be extended as long as possible.

Winesap has a long growing season, usually requiring about 155 to 160 days from full bloom to reach early maturity, and picking (14)<sup>12</sup> should be completed not later than 175 days after blooming. It is one of the very best varieties for long holding, since it softens relatively slowly in storage. If placed in cold storage at once after picking and held at a temperature of 31° to 32° F., Winesap will remain in a crisp, firm condition until early summer. In general, the pressure test will be 20 pounds or above when the fruit is in best picking condition.

Prior to reaching a good maturity for picking, the fruit tends to adhere tightly to the spurs, but under some conditions fruit of this variety has a tendency suddenly to loosen and drop badly just when it has reached the most desirable harvesting maturity. Commercial expediency, therefore, demands the use of a harvest spray; and consequently ease of separation cannot be used as an index of the time to pick the fruit. Although it is desirable to leave Winesap fruit on the tree as long as possible so that it will improve in size, color, and resistance to storage scald, it is well to keep in mind that the Winesap is rather subject to water core as it advances in maturity, especially in seasons of warm days. There is relatively little likelihood of the fruit becoming too ripe on the tree for good quality, provided it is picked before severe water core develops.

For long holding, the fruit should be placed in cold storage at an early date after picking. Winesap, in common with other late-keeping varieties, ripens less while on the tree than in common storage at prevailing fall temperatures. If common storage is to be used, therefore, the later picking is delayed, within limits of weather and water core development, the better the storage response of the fruit.

The variety is subject to soft scald; this disease frequently has been associated with the practice of transferring the fruit to cold storage at 31° to 32° F. after several weeks in common storage at higher temperatures. When cold storage has been delayed Winesap should be held in a storage temperature of 36°.

## YELLOW NEWTOWN

The Yellow Newtown (Albemarle Pippin, Newtown Pippin) variety is grown principally in the Pacific Coast States and in Virginia. It is a firm, slow-ripening variety suitable for long storage, similar in these respects to Winesap. In the Pacific coast section it has a long growing season of 160 to 175 days although picking frequently starts 155 days from bloom. In Virginia it has become the custom to start commercial picking relatively early, frequently less than 145 days from bloom. This variety does not scald badly when packed with oil paper unless picked extremely early, and as it is not necessary to leave the fruit on the tree for color development there is less reason for late picking than with some other varieties. However, late picking is very desirable from the standpoint of increased size of fruit and better flavor. As grown on the Pacific coast, Yellow

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<sup>12</sup> See footnote 2. p. 2.

Newtown apples adhere well to the tree until relatively late, but under Virginia conditions they may start dropping prematurely in some seasons. There is a tendency also toward red spotting of the skin with a consequent lowering of grade when the fruit is allowed to remain on the tree until very late.

Ground color changes in the Yellow Newtown are not sufficiently marked to serve as an index of picking maturity, as the fruit when picked usually is still green, corresponding to No. 1 of the color chart. With a light crop the ground color starts turning yellow earlier than with a heavy crop. Fruit from light-crop trees apparently matures earlier and should be picked before the greener fruit on heavy-crop trees. As previously noted, fruits of other varieties react in a similar way to crop size.

Probably the most satisfactory index of the time to pick Yellow Newtown is the elapsed time from full bloom. Picking should not start until at least 150 days from bloom (8). By this time the apples will ripen with just passable dessert quality and will not be likely to develop storage scald when packed with oiled paper. Much better dessert quality and larger size will be obtained by delaying picking until 160 to 170 days from bloom, as reported for the Pacific Northwest (16).<sup>13</sup> However, under Virginia conditions the dropping or fruit spotting, and under Oregon conditions fall rains and perennial canker infections, may make such late picking unfeasible.

Like the other long-keeping varieties, Yellow Newtown intended for common storage should be picked late. The fruit softens less rapidly on the tree than while being held at prevailing outdoor temperatures. Consequently, delaying the picking of this variety as long as possible within weather limitations will improve its keeping quality if the fruit is handled in common storage.

### YELLOW TRANSPARENT

The Yellow Transparent apple is a very acid fruit that is generally picked in a rather immature condition and used primarily for sauce. Generally it is picked ahead of Williams; such picking would make its harvest period about 65 to 70 days from bloom.

### YORK IMPERIAL

York Imperial is similar to Arkansas in that its possible storage life is determined almost entirely by the development of storage scald; hence it should be picked at the latest possible date. The fruit softens slowly in both cold and air-cooled storage. In cold storage particularly, the fruit usually shows storage scald while still firm, and even in air-cooled storage the possible holding period usually is determined by scald development rather than by the ripeness of the fruit.

Picking of this variety should not begin earlier than approximately 155 days from bloom. Fruit picked after this time and packed with oiled paper should not scald excessively during the normal storage season.

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<sup>13</sup> See footnote 2, p. 2.

In general, it may be stated that the later York Imperial fruit is picked the better its storage quality will be. Unfortunately, this variety tends to drop very badly during certain seasons, so that picking is often necessary before the fruit reaches the best storage condition. Harvest sprays are helpful in preventing dropping but generally have been less successful with York Imperial than with earlier ripening, longer stemmed varieties, in which the apples do not crowd each other off from the spurs by pressure of their own growth. If the fruit is holding on the tree, it should be left until the ground color attains a shade corresponding to No. 2 to No. 3 of the color chart. When the fruit reaches this condition the pressure test usually will be about 20 to 18 pounds. The fruit often begins to drop so badly, however, that picking is necessary before it reaches this condition. Fruit to be placed in common storage should be held on the tree as long as possible before picking. York Imperial is a very satisfactory variety for holding in air-cooled storage, since it will remain firm for a considerable period even if held at moderately high temperatures.

### PICKING TIME IN RELATION TO HANDLING

It should be noted that when the different varieties remain on the trees until late or until the flesh is soft they become very sensitive to mechanical injury. Stayman Winesap, Delicious, and Jonathan testing 16 pounds or less are not only easily bruised but are also extremely susceptible to stem puncture and other mechanical injuries. This is true also of Northern Spy and McIntosh when in condition for picking. When harvesting is delayed for any reason, particularly with these tender-fleshed varieties, unusual care in handling is essential. The details of handling apples are discussed by Fisher (6).

When picked at an early stage of maturity apples of many varieties are rather susceptible to injuries from washing, especially where the washing solutions are heated. With advancing maturity, changes in the wax of the skin give the fruit added protection and permit the use of washing solutions of higher temperatures or stronger concentrations. Where heavy spray residues necessitate severe washing treatments, it is advantageous to permit apples to reach optimum maturity on the tree to avoid the hazards of washing injuries. On the other hand, if they are left on the trees until they have a heavy covering of wax, residue removal will be difficult and some type of wax solvent may have to be incorporated in the washing process to remove the residue effectively.



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