Jonathan Apple Quality and Storage Life
Michigan State University
Cooperative Extension Service
Farm Science Series
D. H. Dewey and D. R. Dilley, Department of Horticulture
August 1968
4 pages

Extension Bulletin 627 Farm Science Series August, 1968

JONATHAN APPLE

Quality and Storage Life

Cooperative Extension Service • Michigan State University

by D. H. Dewey and D. R. Dilley
Department of Horticulture

THE JONATHAN is widely known for its fine eating quality as both a fresh and processed apple. A tender, crisp and juicy flesh, medium to high acidity in combination with a high sugar content, and good flavor account for its popularity as a fresh apple. It is well-accepted for processing because of good juicing and freezing characteristics and suitability to such specialties as canned apple rings.

Until controlled atmosphere storage was developed, the Jonathan variety was considered to have short storage life and best marketed or processed within 3 or 4 months after harvest. Now, providing that the fruit is harvested at the proper stage of maturity, Jonathan can be successfully stored for as long as 6 to 9 months and made available throughout the fall, winter and spring months.

Small to medium size apples with a bright red skin color covering one-half to three-quarters of the surface usually are of best quality for long-term storage and late marketing, larger and more highly colored apples are best for fall and early winter.

Extending the life of the fruit has not been without difficulty because Jonathan apples are susceptible to numerous physiological or functional disorders. In addition, modern markets demand that apples of the red varieties be large and fully colored. Jonathan with these attributes can age and deteriorate more rapidly than smaller, less red apples, even when harvested at the same stage of physiological development.

This publication will discuss growing, handling, and storing high quality Jonathan apples for different market outlets.

INTERNAL DISORDERS

Internal breakdown is a major storage difficulty with Jonathan apples. Letting the fruit become somewhat ripe before picking, prolonged holding of the harvested apples in the orchard or in processing yards or sheds, and extending the storage period too long, can hasten this disorder of old age. A combination of these circumstances sometimes causes difficulties which occur within a few weeks after harvest, and the causes are usually readily recognized. Serious difficulties often arise when a handler overlooks or is unaware of the condition of the fruit or proper handling procedures. Thus, a quantity of fruit suddenly becomes unsuitable for use without an obvious or immediate cause. A description and causes of internal breakdown follows later.

RECOMMENDATIONS FOR STORAGE QUALITY

1. **Put into storage only apples which are:**
   - **— Grown on relatively mature trees of moderate vigor and without extensive late season growth.**
   - **— Small to medium in size, generally not exceeding a diameter of 2¾ inches.**
   - **— Mature, but not ripe, as indicated by the appearance of the ground or under color, flesh texture and taste, and the Cooperative Extension Service harvest date recommendations for your area.**
   - **— Relatively free of water core. Avoid storing apples with extensive water soaking or darkening of the core area, or areas ¼ inch diameter or more around the vascular bundles in the flesh.**
2. **Promptly move apples from the orchard into storage for immediate cooling to storage temperature. If delays in handling are unavoidable, they should be recognized for their possible effect on storage life — each day at 50 to 75° F following harvest shortens fruit life by at least 3 days in cold storage and 6 days in CA storage.**
3. **Cool to the recommended temperature within a week after harvest.**
4. **Store in cold storage at 35° F.**
5. **Store in controlled atmosphere at 32°F, 2.5 to 5% carbon dioxide and 3% oxygen. While apples should be cooled to 32° F upon placement into storage, the room must be sealed and the atmosphere control started within 2 weeks after the first load is placed in the room. All fruit should be cooled to at least 35° F before sealing the room and carbon dioxide should be held at 2.5% or lower until the oxygen reaches 5%.**

The development of controlled atmosphere (CA) storage has solved two of the major storage problems — Jonathan spot and soft scald. Yet, this method of storage is not a cure-all since there is often a tendency to over-extend the safe storage period.

Brown heart is another CA storage disorder. Certain characteristics which make the fruit susceptible to internal breakdown also make it susceptible to brown heart, but the circumstances of their occurrence are quite different. Internal breakdown can occur anywhere and anytime — in the orchard, processing yard, common or cold storage, CA storage, in market channels, or the home. It may appear shortly after harvest or after 9 months or more of storage. Brown heart occurs only in CA storage and only during the storage period. Unfortunately, it may go unnoticed until the fruit is marketed or consumed, as much as 3 to 6 months after development.

Internal Breakdown

Internal breakdown first appears as a light-brown discoloration of the flesh in areas of indefinite outline and usually near the skin or the vascular bundles (Figure 1). Further browning occurs with aging so that practically all the flesh may become affected, with the skin becoming dull and dark in color.

Many variations in the appearance of the flesh may occur. Sometimes a ring of healthy flesh remains near the skin while the rest is brown colored, at other times the discoloration and breakdown occurs only on one side (probably the ripest side) or around a bruise or in the calyx end. The core area may remain clear of discoloration or it may be browned, but less dark in color than the affected flesh. As breakdown advances, the flesh becomes soft and bruises readily. Severely affected apples bruise easily from handling and sorting and can generally be detected by a slight squeezing with the hand. The flesh is somewhat dry and mealy, lacking in flavor, usually free of abnormal odor.

Internal breakdown is an old age disorder. Thus, anything which weakens the structure of the fruit, or stimulates or interferes with normal utilization of carbohydrates and other storage reserves within the fruit, hastens its development. The disorder will ultimately develop as a natural product of old age unless the apple is first destroyed by pathological organisms or other disorders. Growing, handling and storage conditions favorable for longevity of the harvested fruit retard the development of internal breakdown.

Brown Heart

This disorder was first called brown heart when it was discovered in the core or pith of apples during the early use of controlled atmosphere storage. It is now recognized as also developing in the flesh or cortex. In the flesh it is usually found around the vascular bundles, or where there has been damage to the tissues by bruising or other means. Usually, it is more prevalent in the calyx than in the stem half of the fruit regardless of whether located in the core, flesh, or both tissues. Brown heart can be prevalent in a given year and scarce or absent in the same situation in other years.

Brown heart first appears as a chocolate-brown discoloration, quite well defined in area, yet without a sharp line of separation between the diseased and healthy tissues, sometimes barely visible, sometimes affecting one third or more of the fruit. The brown-colored tissues are firm and wet at an early stage of development (Figure 2). Later, (usually under continued storage) the diseased tissues lose water, become dry and finally shrivel, leaving empty pockets in the core or flesh (Figure 3). The dead tissue becomes light brown with the discoloration seldom extending beyond the pockets by more than one-eighth of an inch.

There are no external symptoms of brown heart except where large areas of flesh collapse to leave the outer flesh and skin sunken. The disorder is readily discovered by cutting the calyx half of the fruit at 3 or 4 points perpendicular to the axis of the fruit.

Extensive studies of brown heart at Michigan State University show that it usually develops shortly after placement of the fruit in storage, probably during the first month or so under controlled atmosphere conditions. Experimental storage with the fruit in high carbon dioxide and elevated temperatures have increased the amount and severity of brown heart during the storage season. The supply of oxygen as well as the amount of carbon dioxide accumulating within the fruit appear to influence the incidence of brown heart.

Jonathan apples in which the tissues are flooded with water or cellular juices and translucent in appearance either in the core area or around the vascular bundles of the flesh (water core), are more susceptible to brown heart than apples free of water core. The pattern of brown heart when fruit is taken from storage is often similar to the pattern of water core in fruits examined at harvest. Presence of the water core disorder at harvest is a good indication that the fruit is overmature and unsuited for long-term storage.

Large apples ($2^3/_4$ inches and greater in diameter) are more likely to develop brown heart than smaller fruit.

Control or Prevention

Control measures for both internal breakdown and brown heart are preventive rather than corrective. Fortunately, pre-storage factors affecting their development in storage are the same for both disorders so that measures followed to reduce the chance of internal breakdown will likewise reduce chances of brown heart. The principle characteristics indicating susceptibility of an apple to either disorder are large size, over-maturity (sometimes indicated by a full red coloration or a yellow ground cover) and presence of water core. Growing and handling practices seem to affect both disorders in the same way.

Growing and Handling

Apples which are large, overmature, or forced late in the growing season are likely to develop internal breakdown and brown heart. Apples grown on young trees, on trees with light crops, or under nutritional or climatic conditions causing rapid expansion and large fruit size during the last 4 or 6 weeks of the growing season should be segregated from other fruit at harvest and set aside for immediate processing or marketing. Apples on young or light crop trees often ripen ahead of apples on mature or medium to heavy-crop trees, and must be picked earlier. Even so, they are likely to have a limited storage and shelf life and are not recommended for long-term storage.

Jonathan apples 2¾ inches and larger in diameter are generally unsuitable for late processing or marketing because of their susceptibility to internal disorders. Apples 2½ to 2¾ inches in diameter sometimes show excessive damage when held for long periods, but the hazards are considerably less than for larger fruit. When harvested at the correct time, properly handled and stored, the risks are relatively small even when marketed from CA storage the following spring. Under proper conditions, apples less than 2½ inches in diameter invariably store well.

The amount and intensity of red color in the skin of Jonathan apples is a poor guide to fruit maturity and ripeness — some highly colored apples are barely mature enough for harvest, while others with little or no red color are ripe. The change in ground or under color from green to yellow is a useful guide, yet it is sometimes masked by red color. Yellowing may be delayed due to high nitrogen conditions or late growth.

Probably the best guide for proper time of harvest is the development of good flavor and eating texture of the flesh. The Cooperative Extension Service yearly recommendations should be used as a guide for harvest dates of fruit from a particular block or orchard. Good judgment on the part of growers is essential since many variable conditions of growth and maturation do occur. Because Jonathan apples do not drop as readily as Delicious when approaching maturity, there is a tendency to preferentially harvest Delicious before Jonathan harvest has been completed. Overmature Jonathans are not a serious problem when apples are handled and marketed accordingly. The error lies in mixing them with sound fruit for long-term holding and late marketing or in failing to recognize their susceptibility to internal disorders.

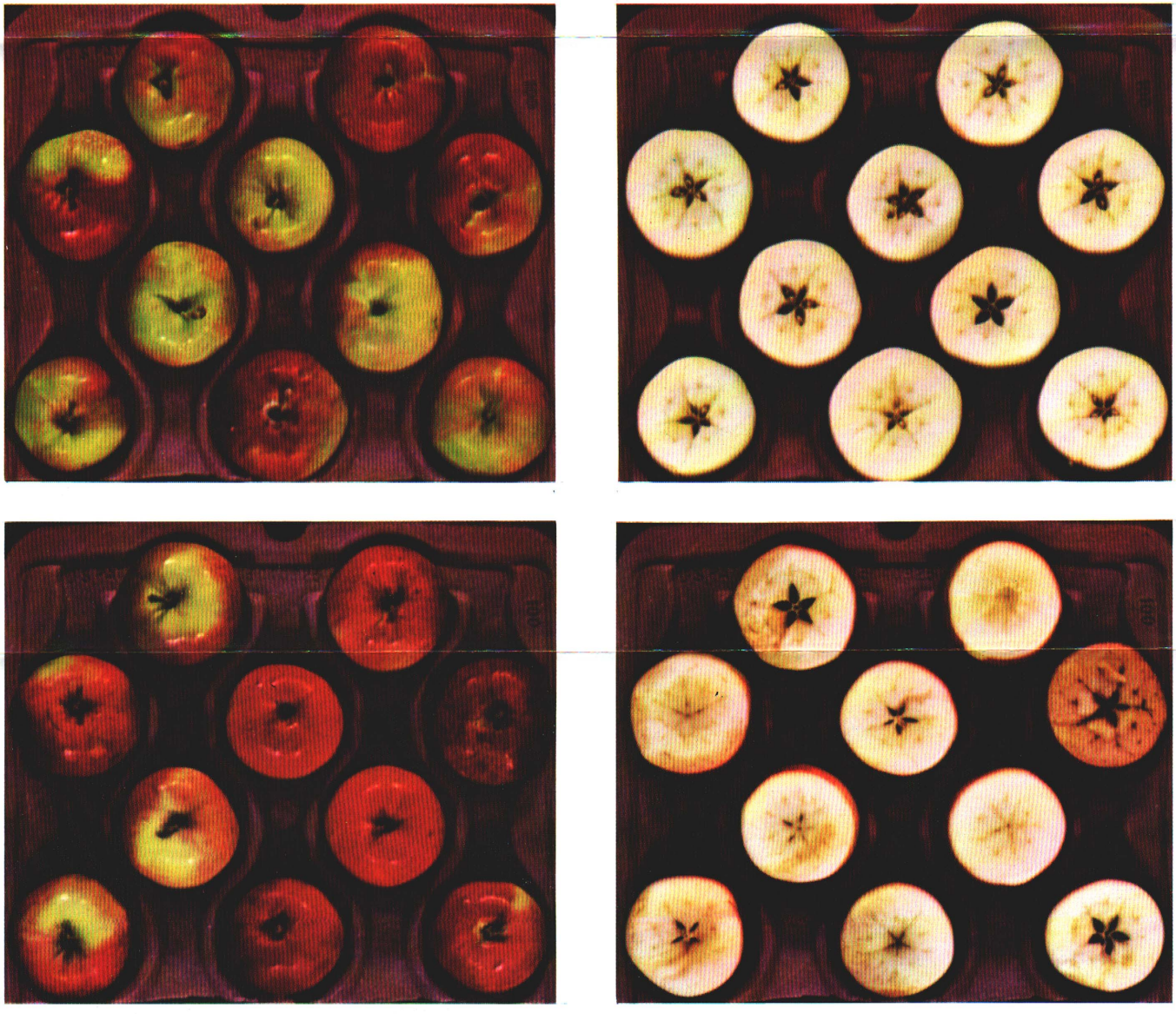

Fig. 1 Jonathan apples harvested in a northern Michigan orchard in 1967 and stored until March. The apples, top left and right, were picked September 25; they show only a fair amount of red coloration, left, but remained free of internal breakdown development during storage, right. Those at lower left and right were picked one week later from the same trees. Although of excellent red color, bottom left, every fruit shows a trace to severe internal breakdown when cut, upon removal from storage, bottom right.

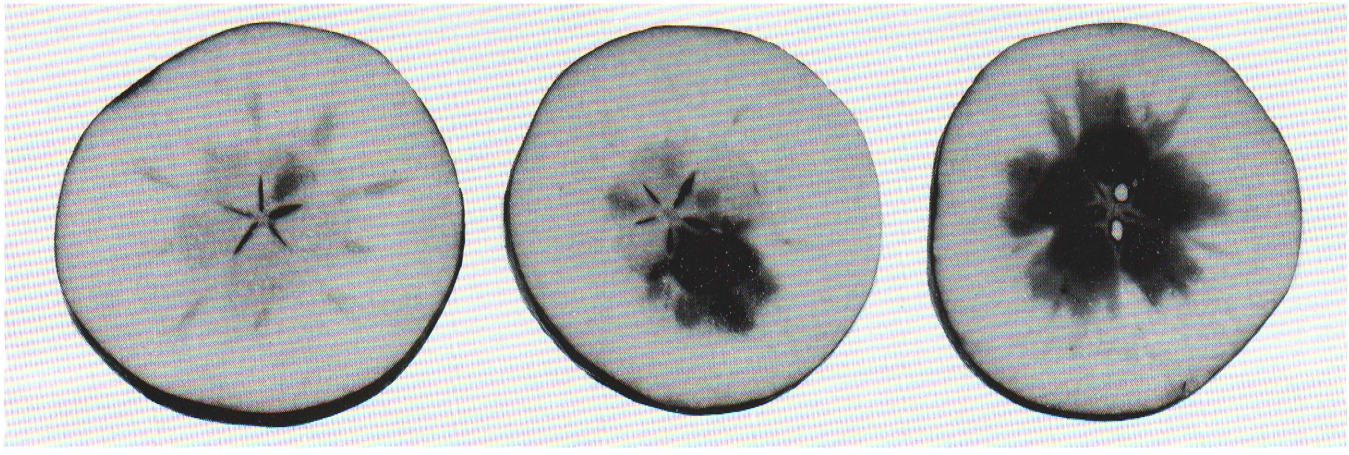

Fig. 2 Brown heart in the early stages of development. The apple at left has slight amounts of water core in the flesh and core and a single small area of brown heart between two of the seed cavities. The other two apples show extensive brown heart. At this stage affected tissues are moist and chocolate-brown in color — later dry out and appear as in Fig. 3.

Storage and Marketing

Deterioration from advanced ripening can be greatly delayed by proper use of low temperatures. As much aging takes place in a week at 70° F as in a month at 35° F and is greatly increased at higher temperatures.

Fruit left unpicked for a week after reaching ideal harvest maturity and left in the orchard, yard or shed for another week after picking, will have already lost months of potential storage life. Further life is sacrificed by slow removal of field heat. Often, much of the fruit does not reach desired storage temperature for several weeks. Furthermore, continued storage at too high a temperature will also shorten the life of the fruit. These effects hold true for controlled atmosphere as well as cold storage. A week of exposure of harvested fruit to high temperatures can shorten the potential CA storage life by as much as 2 months.

The exact causes of brown heart in storage are not specifically known. In general, the disorder is minimized in CA storages when the apples are cooled to 35° F or lower before the room is sealed for atmosphere development; carbon dioxide is held at a low level (e.g. 2.5%) until the oxygen is reduced to at least 5%; or carbon dioxide is never permitted to exceed 5 or 6% throughout the storage season. It may still develop, but only in apples of large size, overmature at harvest, or seriously affected by water core. Brown heart rarely occurs in other apples when stored under proper conditions at temperature, carbon dioxide and oxygen.

When grown, handled and stored properly, Jonathan apples will remain in excellent condition for 3 to 4 months in cold storage at 35° F and up to 6 to 8 months in controlled atmospheres. Many apples do not meet these requirements, yet they are of excellent quality and well suited for marketing or processing during the harvest season or in the late fall and early winter. However, they also require prompt cooling and holding in cold storage at 35° F in order to delay deterioration and development of internal breakdown. Large, ripe or water-cored apples should not be placed in CA even for relatively early marketing since they can be damaged by brown heart.

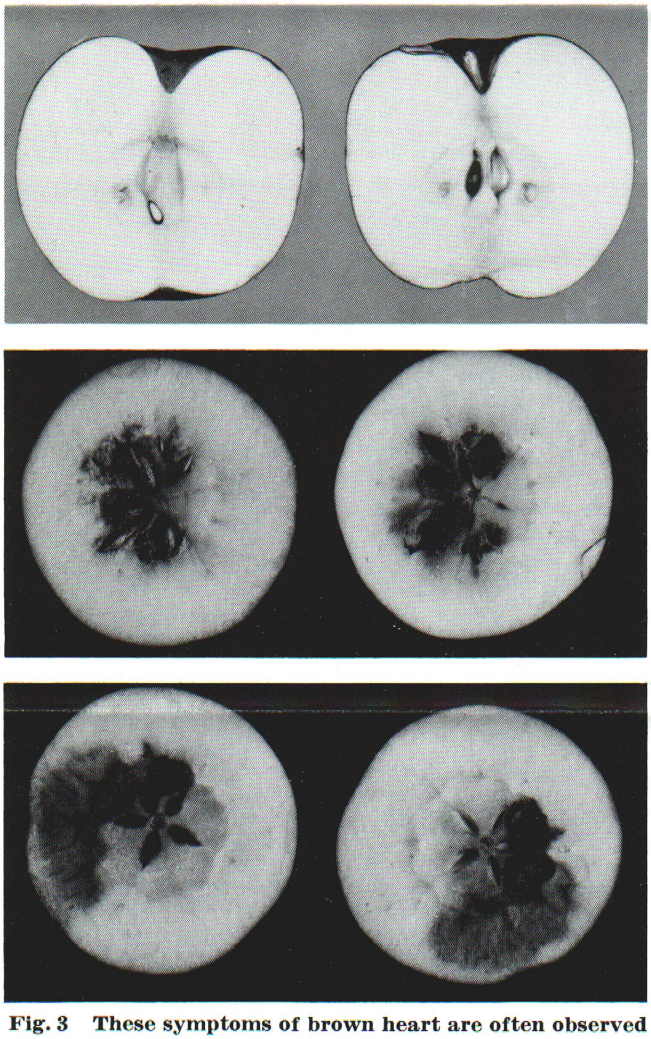

Fig. 3 These symptoms of brown heart are often observed when affected fruits are cut after long-term controlled atmosphere storage. These apples developed brown heart early in the storage period. The affected tissues were killed and then dried leaving the typical pockets or voids in the core and flesh.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U. S. Department of Agriculture. George S. McIntyre, Director, Cooperative Extension Service, Michigan State University, E. Lansing, Mich. 1P-8:68-7.5M-SQ