One Hundred Years of Apples

The Northeastern Section of the American Society for Horticultural Science met in January of 1972 at the Arnold Arboretum for a symposium entitled "A Century of Horticultural Progress." The following article is an excerpt from one of the talks presented. Future issues of Arnoldia will present additional excerpts of talks from these meetings. Ed.

One hundred years ago, the apple industry of this country consisted of seedling trees and named varieties selected from seedlings and propagated vegetatively. The original seeds and plants of a few named selections had been brought from Europe by early settlers.*

Beach's Apples of New York published in 1905 described 698 varieties. The origin of 517 are listed as unknown, while the remaining 81 varieties were said to have resulted from seed planted without knowledge of either parent. According to one authority, by 1912 more than 3000 varieties had been described. A few of these developed from seeds supplied by one known and one unknown parent variety. The large majority were chance seedlings with both parents unknown.

The Breeding Program

Prior to 1878 there was no systematic breeding work aimed at improving apple varieties. Between 1878 and 1925 apple breeding programs were initiated at eleven state experiment stations and by the U.S. Department of Agriculture. By 1937 these breeding projects had over 100,000 apple crosses under tests, and the number has increased during the past 35 years.

Today approximately 15 varieties account for 90% or more of the total apples produced in this country. All except Cortland originated as chance seedlings. Cortland is the only variety of any significant commercial importance that has resulted from the breeding program, and its production is limited to the Northeast region where it amounts to less than 10% of the total crop. There are, of course, numerous new varieties that have emerged from apple breeding projects that are being

tested by the industry. But none have as yet become commercially important.

One of the reasons for this is that it takes 40 to 50 years from planting the seed of a new apple for the industry to accept or reject the new variety. Another problem is the fact that all apple varieties are a result of many mixed ancestors, also they are self sterile which means one generally cannot fertilize a flower with its own pollen to keep the strain intact. In the past promising seedlings were often found by chance in open fields and hedgerows but this is no longer true. Therefore long-time breeding programs must continue if further improvement of apple varieties is to be realized, and certainly further improvement is possible and is needed.

Changes in Production

Prior to 1940 research aimed at improving production of apples was, in the main, limited to variety selection and trials, cultural practices including fertilizer testing, pruning, and pollination requirements. Yields ranged from 200 to 400 bushels per acre depending on variety, soil and management. The annual crops alternated significantly, resulting in a light crop one year followed by a heavy crop the next year. During the past 30 years more changes have occurred in the apple industry in eastern and mid-western areas of the United States than in all of its previous history. These changes were the result of modern technology and can be seen in a study made in New York State. In 1939 there were slightly over 5 million apple trees in the state of New York, yielding 19 million bushels of apples. In 1966 there were close to 2 1/2 million trees giving 22 1/2 million bushels of apples.

Several diseases and insects attack the apple. In humid areas, such as the Northeast section of the United States, apple scab (*Venturia inaequalis*) affects both foliage and fruit. Sprays for control of this disease are essential for the production of acceptable fruit. Apple growers began to use Bordeaux sprays for scab control about 1890 and continued this practice until 1910. These copper sprays caused russet on fruits. Following the work published by the Cornell University Agricultural Experiment Station in 1909–10, lime-sulphur sprays replaced the copper compounds. Sprays of elemental sulphur were initiated in the mid-1920's and increased in use during the 1930's. These sulphur sprays, both lime sulphur and elemental sulphur for scab control, were standard practice for the 40-year period 1910–1950.
In the early 1930's, it was shown that sulphur sprays, when employed as a fungicide reduced the process of photosynthesis by apple foliage in amounts ranging from 30 to 50 per cent depending on material and conditions at the time of application. Comparing elemental sulphur and lime sulphur as a seasonal fungicide program on mature McIntosh trees for a 5-year period, an increased yield of 225 bushels per acre was found in favor of the elemental sulphur. In a similar field experiment on mature McIntosh trees where Fermate was compared with elemental sulphur, there was an increase in yield of 200 bushels per acre in favor of Fermate. Thus increased yields of the McIntosh variety amounting to over 400 bushels per acre were obtained by the development of nontoxic organic fungicides. Similar results have been reported by other investigators throughout the eastern apple districts of the United States. These field experiments were excellent confirmation of the earlier work on effects of sulphur sprays on photosynthesis.

While emphasis on confining plantings to the better varietal selections, improved nutrition, the correction of soil acidity resulting from 40 years of sulphur sprays, and the limiting of plantings to the best soils and sites have been contributing factors, the development of non-toxic fungicides and insecticides was certainly the most important contribution to obtaining significantly better yields of fruit.

Harvest Drop

As apples mature, the fruits of some varieties may absciss and drop. The harvest drop problem varies with the variety. McIntosh is notorious for this fault and if warm weather prevails during the latter part of the harvest fifty per cent or more of the crop may fall from trees before they can be harvested. In 1939 it was learned that a spray containing naphthaleneacetic acid at concentrations of 10 to 20 parts per million would delay abscission and control harvest drop. Later work showed other growth regulating chemicals were effective for this purpose when used as preharvest sprays. Adaptability of these chemicals vary with the variety. The grower has considerable choice and is now in a position to control fruit drop of his apple crop until the harvest is completed.

Changes in Cropping Habit

When left to its natural fruiting habit the apple is characteristically biennial; i.e. a heavy crop is followed by a light crop.
This phenomenon has been recognized since the beginning of apple culture. There is now good evidence that the seeds in developing apple fruits are the guilty organ which have some unexplained physiological effect in inhibiting flower bud formation. When there are too many fruits with too many seeds, the newly formed spur buds remain vegetative and there is little bloom the following year.

Biennial bearing creates marketing problems. There is a year to year irregular supply to the consumer. The grower is plagued with too many small fruits in the heavy crop year and too few fruits in the light crop year. While growing costs up to harvest time are approximately the same in the heavy crop year as in the light crop year, fruit prices are low when the crop is excessive and high when the crop is light. Biennial bearing is uneconomic.

Thinning or removal of excessive fruits is the only practical means of assuring annual bloom and annual cropping. The thinning must be accomplished within 3 to 4 weeks of bloom or else many buds will have passed that stage in which they can be influenced to form flowers. Even if labor were available, hand thinning of commercial apple plantings sufficiently early to assure annual flowering would be impractical.

Research on the possibility of spray-thinning apples was started in 1940. The early work involved bloom sprays (of dinitro-ortho-cresol) which prevented fruit set by unpollinated flowers. During the 1940’s and 1950’s it was learned that the growth regulating chemicals (naphthaleneacetic acid and its amide, naphthaleneacetamide) would reduce fruit set when applied during the post bloom period. In 1959 Sevin (1-naphthyl N-methyl carbamate) was found to be effective in thinning apples when used as a post bloom spray.

Early results varied from overthinning to no thinning. With continued effort a better understanding of those factors which influence results was obtained and the extremes in amount of reduction in fruit set have been brought closer together so that present day results may average within ten per cent of the amount desired.

During the 20-year period, 1935–1955, the light year apple crop in New York State averaged 14 million bushels while production in the heavy crop years reached 22 to 23 million bushels. The average extent of alternation for this 20-year period was 35 per cent. Spray thinning of apples became a widely used practice during the late 1950’s and early 1960’s. With commercial use of the practice annual cropping during the
1960's has ranged between 22 and 24 million bushels. This is a better situation for both the apple industry and the consumer.

The Golden Delicious apple originated as a chance seedling in West Virginia. It was named and introduced in 1914. From the few early plantings it was soon learned that Golden Delicious set heavy crops, required much hand thinning and was completely biennial. There was little interest in the variety until the mid-1950's when growers recognized that spray thinning would solve the problem. Then planting of Golden Delicious increased rapidly. In 1969 production of Golden Delicious exceeded McIntosh production and today Golden Delicious is the second most important variety grown in the United States. Thus, technology made an important commercial variety from a chance seedling that otherwise would have been discarded.

**Developments in Storage**

Apples must be held in some type of storage, if there is to be a supply of fresh fruit during the winter. The fruit cellar, with its dirt floor, served this purpose in rural America during the early years and explains why certain varieties possessing good keeping quality, such as Roxbury Russet, a Golden Russet, were popular in those days.

As the urban market developed, the common storage came into use to supply this outlet and lay the foundation for a commercial apple industry. The common storage was an insulated structure which was cooled during fall months by introducing cool air at night through suitable ports. All openings were closed during the day. The cool air introduced at night was circulated by gravity or forced through the storage by fans. Cooling of the common storage with night air was sometimes supplemented by the use of ice. This type of storage was used for many years. Bulletins published as late as the mid-1930's describe the best designs and techniques for operating the common storage. The main disadvantage of the common storage was the slow removal of field heat from fruit. This was a serious problem during harvest seasons characterized by warm weather.

To overcome the faults of common storage, interest in refrigerated storage was initiated during the first decade of this century. The first ones consisted of refrigerated warehouses centrally located in fruit areas or large cities. As rural electrification developed and refrigeration equipment improved during the 1930's, refrigerated storages began to appear on individual fruit farms. By 1950 there were several hundred re-
frigerated farm storages throughout the fruit areas of New England and New York.

Apples can be held satisfactorily for rather long periods in refrigerated storage. The length of the storage period in this type of storage depends on the variety and other factors. For example, when McIntosh are stored later than January in refrigerated storage with normal atmospheres, the fruits are susceptible to a storage disorder known as brown core. Because of the importance of McIntosh in the New England and New York areas, research on Controlled Atmosphere (CA) storage was initiated in 1937. This type of storage was based on the established principle that if the amount of products involved in a given reaction can be controlled (in this case, the involvement of oxygen and carbon dioxide in respiration), the rate of the reaction may be controlled. The original experiments on McIntosh in CA storage more than doubled the period over which this variety could be satisfactorily held in refrigerated storage with normal atmospheres. The first commercial CA storage room for apples in this country was constructed by a New York State apple grower in 1940. It had a capacity of 10 thousand bushels. Thirty-one years later, 18.0 million bushels of the 1971 U.S. apple crop was placed in CA storage. The Northeast area, including New England, New York and New Jersey account for approximately one-third or 6.2 million bushels of the present CA storage space. By varying slightly the per cent of oxygen and per cent of carbon dioxide for different varieties, the CA environment has proven well-adapted to most varieties. Thus CA storage as a supplement to refrigerated storage with normal atmosphere, has extended the marketing season for fresh apples throughout the late winter, spring and early summer months or until early varieties of the following year's crops begin to mature. The present day consumer is never without the opportunity to obtain fresh apples.

During the storage period, the greatest losses to the apple industry have been due to a physiological disorder known as scald. This nonparasitic storage trouble causes the skin to turn brown and the fruit is unsalable in fresh fruit channels. In its late stages scald affects the fruit so deeply it cannot be properly peeled for processing. Four decades of research have given no satisfactory explanation of the basic causes of scald. Susceptibility of apples varies from season to season. While climate during the growing season seems to play a part in susceptibility of stored fruit, all factors responsible for a "bad scald year" have not as yet been defined.
Prior to 1955 the only means of scald control in significant amounts was the wrapping of individual fruits in paper treated with white mineral oil, or by mixing shredded oiled paper with packed fruit. This method calls for grading, wrapping and packing prior to storage, rather than on removal of fruit from storage when grading and packing for market can be more appropriately done. In 1956 it was reported that DPA (diphenylamine) showed promise as a chemical treatment for scald control. Further research efforts on this approach indicated another chemical, Ethoxyquin (6-ethoxy-1,2, dihydro-2,2,4-trimethyl quinoline) had similar effects. Developmental work with these two chemicals has shown that dipping the fruit is the most effective means of scald control with either DPA or Ethoxyquin. Dipping assures complete fruit coverage. Concentrations of 1,000 to 2,000 ppm. of DPA or 1,800 to 2,700 ppm. of Ethoxyquin, depending on variety, are appropriate.

Other methods of treatment such as spraying the fruit on trees just prior to harvest or spraying it after harvest in field containers or as it passes over grading machinery has given significant control of scald. But these methods are not as effective as dipping for complete coverage.

Because of susceptibility to scald in CA storage, the Cortland apple could not be held in this type of storage prior to the discovery of chemical control for scald. This development has been responsible for maintaining Cortland at its present level on the commercial list.

The apple industry now has a simple chemical method for scald control, which when properly used will avoid the heavy losses of previous years. At present, approximately 15 million bushels of apples are treated annually for scald control.

As in the production of apples, the past 30 years has brought tremendous improvements in the storage and length of marketing season of this important fruit. While costs experienced by the apple industry have risen significantly in recent years, the wholesale price has increased little, if any. Technology has made this possible.

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