THE HANDLING OF DECIDUOUS FRUITS ON THE PACIFIC COAST.

By A. V. Stubenrauch,

Expert in Charge of Fruit Transportation and Storage Investigations,

Bureau of Plant Industry.

INTRODUCTION.

The fruits classified under the general term “deciduous fruits” are those produced by trees which drop their leaves in winter. They are called “deciduous” to distinguish them from the citrus fruits, which are borne on evergreen trees. The fruits which come under this designation, and which are shipped in a fresh state from the Pacific coast, include apples, apricots, cherries, peaches, pears, plums (including prunes), nectarines, grapes, and the small fruits, such as strawber ries,\(^a\) raspberries, and blackberries. The handling problems included in this article refer to the preparation of the fruit for shipment and for marketing in the fresh condition, although the greater part of the deciduous fruits grown on the Pacific coast is marketed not in a fresh condition, but as canned and dried fruits of all kinds, including prunes and raisins.

There has been an enormous growth and development of the deciduous-fruit industry on the Pacific coast. Up to twelve years ago most of this development had been in California, where the fresh-fruit shipments in 1909 equaled 15,280 carloads, but recently the planting of deciduous-fruit orchards in the States of Oregon, Washington, Idaho, Colorado, and Utah has been made on a very large scale. The development of these new districts and the rapid increase in the production of deciduous fruits have alarmed many of the growers, especially in California, at the possibility of overproduction, and the advisability of adopting means to prevent further planting, or at least to stop overdevelopment and the booming of new regions by land speculators, has been seriously discussed. Plans are being made to increase the demand for and consumption of these fruits by advertising and by the development of new markets. It is at last realized that too much attention has been given in the past to the business of inducing people to plant fruit trees and that not enough consideration has been given to the selling of the crop and to finding a profitable market for the fruit that is already on hand.

\(^a\)While the strawberry holds its leaves through the winter, its fruit is similar to the deciduous fruits in its shipping requirements, and it is therefore classed with them.
TRANSPORTATION PROBLEMS.

The problems connected with the transportation of deciduous fruits from the Pacific coast are essentially problems growing out of the necessity for wide distribution. Ever since the first carload of fresh fruit was shipped from California, in 1869, the bulk of each crop has had to be marketed in the Eastern States. It is a remarkable fact that this business, built up on the far western edge of the continent, has been and will for many years continue to be almost wholly dependent upon the Atlantic seaboard and adjacent States for a market. The fruit has to be transported 3,000 miles, crossing lofty mountain ranges and hundreds of miles of desert, to the cities and centers of population of the East and Central West. Great engineering problems have had to be solved in accomplishing this result. It is stated that in crossing the continent a car has actually to be lifted or raised a vertical distance of more than 2 miles. Upon the safety, efficiency, and dispatch of the transportation facilities depends the whole success of the fresh-fruit industry of the Pacific coast. The perishable nature of the product and the difficulty in handling such an industry 3,000 miles from the center of consumption have made it necessary to develop an ample and efficient fruit-refrigerator-car service, which is now admitted to be the largest and best of its kind in the world.

The distance which the fruit has to be transported and the expense and risk involved necessarily require that the fruit reach the market in the best possible condition. This has enforced a degree of uniformity in grading and packing which, together with the high shipping qualities of the western fruits, is largely responsible for the successful marketing of the Pacific-coast product in competition with the eastern fruits produced near the markets, but which, taken as a whole, are not as attractively or uniformly packed. The difficulties and the expense of shipping and marketing the Pacific-coast fruits to some extent safeguard the grower against the temptation that confronts the eastern grower, with near-by markets and lower freight rates, to attempt to market large quantities of inferior, badly graded, and poorly packed fruit.

It must not be assumed that no poor packing is done and that no poor-grade fruit is shipped from the Pacific coast. In fact, much of the western fruit has the reputation of being poor in quality, though often beautiful in color and fine in appearance. This reputation has not militated to any great extent against the sale of western fruit, owing to the fact that the consumer has thus far bought fruit products principally on appearance. But as competition grows keener and as high-grade fruit from near-by sections comes to be more carefully and attractively packed so as to reach the market in sound condition,
fruit of poor quality will suffer. The poor quality of some of the western fruit, especially the peaches, apricots, plums, and other quick-ripening fruits, is the result of picking long before the fruit reaches full maturity in order to protect it against the ripening which takes place during the transcontinental trip. After fruit is picked the ripening processes progress much more rapidly than they do under the same conditions of temperature while the fruit is on the tree. Unless some means are employed to check this ripening as soon as harvested the fruit is too far advanced, even under the present method of refrigerator-car shipment, before it reaches the market.

The overcoming of this difficulty is one of the most important problems connected with the handling and the shipping of deciduous fruits on the Pacific coast. The peach growers of the Pacific Coast States have this problem to face in insuring the good quality and sound condition of their product on arrival in the markets. The grape growers of California and other States find their markets and their season of marketing limited, and in order to provide for the increased production from young plantings both markets and season must be extended. The raspberry growers of the Puyallup district in Washington desire to extend the marketing of their product beyond the present limits. The cherry and prune growers of the Willamette Valley of Oregon have to overcome quick ripening and deterioration in order to lengthen their marketing season and to extend to markets which it is now impossible to reach. The pear growers of the Rogue River Valley and the Jonathan apple growers of the Hood River Valley in Oregon also find their markets limited by lack of proper facilities to provide against the quick ripening and the deterioration of their product.

HANDLING, PACKING, AND MARKETING.

The deciduous fruits are produced under the most diverse conditions—in the valleys, in the foothill and mountain districts, under irrigation, and with natural methods of tillage. Under such varying and extreme conditions the product varies in quality and appearance as well as in season. It is owing to this diversity in the conditions of production that the problems of deciduous-fruit handling and of marketing have not been systematized and organized as they have been in the citrus-fruit industry. The citrus-fruit industry is largely organized into associations of growers. The fruit of the different growers is uniformly graded and packed in central packing houses owned by the association, each packing house having its own brands to designate the different grades. The fruit is not shipped under the name of the grower who produces it, as all of the fruit of the same grade is pooled. Many of the associations of growers also pick and
haul the fruit of the members to the packing house. They have developed trained gangs of pickers and other laborers who work under efficient foremen, and they, more than those engaged in any other agricultural industry in the country, have evolved methods to insure the careful and uniform handling of the product.

In the handling of deciduous fruits this system does not prevail except in local areas. There are few central packing houses except in some of the grape districts in California. The greater part of the deciduous-fruit crop is packed in the orchard where it is grown, usually by the grower, except in some of the apple and other fruit districts in Oregon and Washington. While certain standards of grading and sizing are supposed to exist, they fall far short of the uniformity prevailing in the grades and brands of citrus fruits. When packed in central packing houses each grower's fruit may hold its individuality until it is sold. The establishing and maintaining of uniform grades and brands, except in the case of growers having a large acreage, is impossible under this system. It frequently happens that a carload consists of fruit from 25 to 50 growers, each packing and handling in his own individual way. It naturally follows that there is the widest variation in the packing and grading, although the shipping companies have standards to which the grower must conform in a general way.

The one great object in growing fruit is to sell it at a profit. Fruit growing is a business, and as such is dependent upon business methods and principles quite as much as the manufacture and sale of boots and shoes, of steel implements, or of other articles. The manufacturer realizes that the success of his business depends upon the proper distribution and sale of his products, and he pays as much attention to the selling as he does to the manufacturing. It is the business of the fruit growers, either for themselves or through their agents, to study commercial methods and principles and apply them to their industry. With the establishment of better distribution and business methods in marketing fruits, the dangers from overproduction will largely be avoided.

This means, first of all, the production of first-class fruits, uniformly and honestly graded and packed and delivered to the consumer in sound and attractive condition. This is the business of the growers, and is the fundamental factor upon which depends the success of the industry. Too often the growers have ascribed the cause of their difficulties to others—to the shippers, to the transportation companies, to commission merchants, or even to the weather—losing sight of the fact that with the exercise of a little care and good judgment on their part many of these difficulties would not exist. The fruit growers of the Pacific coast have mastered most of the problems relating to the production of the fruit—such as relate to the various
FIG. 1.—DECAY OF APPLE RESULTING FROM PUNCTURE.

FIG. 2.—APPLE PACKING SCENE.

APPLE PACKING, CALIFORNIA.
FIG. 1.—UNINJURED CLUSTER.

FIG. 2.—DECAY DUE TO BRUISING.

FLAME TOKAY GRAPES, CALIFORNIA.
INFLUENCE OF PRECOOLING ON PEACHES.

[Fig. 1.—Hard ripe Early Crawford peach delivered at New York in sound condition by precooling and ordinary icing. Fig. 2.—Early Crawford peach from California, picked green and shipped to New York under ordinary icing in the usual way.]
orchard practices of tilling, fertilizing, pruning, thinning, and spraying. It frequently happens that after a grower has used the utmost care in producing his crop he nullifies all through the handling he gives it in preparing it for market. It does not matter how excellent his orchard practices are, if his fruit does not reach the markets in sound and attractive condition he may find that he receives no more for his crop than a more careless or slipshod neighbor, and he is at a loss to understand why.

During the last eight years the Bureau of Plant Industry has conducted investigations of the factors which govern the shipment and storage of fruits. It has been shown by many experimental shipments that there is a direct relation between the handling and the treatment in all of the various processes of preparing the fruit for shipment and its behavior while in transit or storage. This has to deal with the picking, packing, hauling, and cooling of the fruit.

**MECHANICAL INJURIES.**

It is generally recognized that fruit must be handled with great care if it is to be kept sound, but few have realized, until it has been demonstrated to them, how easy it is to injure fruit in handling and how much injury is actually being done. In the investigations conducted by the Bureau of Plant Industry it was not uncommon to find 10 or 15 per cent of apples injured by rough handling in picking and packing. Plate XXVII, figure 1, illustrates an apple, showing decay started about a puncture; figure 2 illustrates an apple-packing scene in California. Frequently, also, from 10 to 50 per cent of oranges were found to be injured by the clippers in severing the fruit from the trees or in handling it in the packing houses. Again, from 5 to 40 per cent of table grapes were found to be cracked or broken more or less severely at the pedicels.

The work of the Bureau of Plant Industry has shown that the more common kinds of molds which cause decay in transit and storage have not the power to penetrate the unbroken, normal skin of the fruit. It has been shown that the molds generally gain entrance through mechanical bruises or abrasions of the skin made in the handling of the fruit in preparing it for market. Some common forms of such injuries are bruises and scratches made in the picking of the fruit, in squeezing it and dropping it roughly into picking boxes, bags, baskets, or pails, or in pouring it from the field bag or pail into boxes. Hauling on springless wagons (sleds are sometimes used) may seriously bruise the fruit. Dirt, gravel, dried branches, or twigs in the bottom of the field boxes are also a frequent source of injury. Injuries of these types are not only difficult to detect but offer ideal conditions for the starting of decay. Many fruits are injured by scratches made by the finger nails of pickers and packers.
In the case of the soft fruits much bruising results from excessive squeezing in packing. The tips of peaches are most delicate and easily bruised or injured. In examining peaches in shipping and storage experiments tip injury is frequently found to be the greatest source of decay.

Grapes are perhaps the most easily injured of all fruits. An examination of grape berries shows that from 90 to 95 per-cent of the injuries consist of breaks or cracks at the pedicel, the place where the stem joins the berry. Sometimes the bending aside of a berry is sufficient to cause a slight rupture or crack at that point, and all such berries are susceptible to decay when they are packed. This indicates the extreme care with which all handling of grapes must be done. Handling must be reduced to a minimum and always, when practicable, the bunches should be handled by the main stems, for every time a bunch of grapes is lifted there is danger of injury unless it is done with the utmost care. Grapes are often injured in placing them in the baskets—by rough handling, excessive squeezing or crowding, or twisting and binding the long bunches to form compact masses. It has been shown that unbroken grape berries carefully handled and laid in loosely do not decay under normal conditions of shipment, and the nearer the packing can be made to approach this ideal condition the less will be the danger of injury and resulting decay.

Very soft fruits, like cherries or berries, are very easily injured, especially when these fruits are allowed to become over-ripe. It is important to have the picking operations keep pace with the ripening of the fruit. This means going over the cherry trees several times; berry plantations at the height of the season must be gone over daily. The softer or more susceptible the fruit is to injury the more carefully must it be handled throughout all the processes of preparing it for shipment.

During the last two years the transportation investigations of the Bureau of Plant Industry have been extended to the table-grape industry of California. Careful observations on handling methods have been made, and extensive shipping experiments have been carried on in order to demonstrate the results of careful handling in preparing the fruit for market. The experiments consisted of shipping a series of crates and boxes of grapes packed under known conditions through to New York, where the packages were carefully inspected and the actual percentages of decay were determined. The ordinary commercial pack was used in comparison with the same fruit carefully handled by the government investigators. Records on 50 such shipments were obtained during the shipping seasons of 1908 and 1909.
The records of the shipments made in 1909 show an average of 1.2 per cent of decay in the carefully handled lots and 5.8 per cent of decay in the commercial pack of the same fruit. Moreover, this difference was maintained after arrival in New York. The grapes were held for a week under open-market conditions, and determinations of the decay were made three, five, and seven days after arrival. The carefully handled lots were still in merchantable condition five days after arrival, with an average of 5.2 per cent of decay, or less than the average decay found in the commercial packs on the day of arrival. Plate XXVIII, figure 1, illustrates a cluster of Flame Tokay grapes that has been carefully handled and has reached an eastern market uninjured. Figure 2 illustrates a similar cluster that has been bruised, thus giving entrance to decay. The decay in the commercial packs had reached 15.8 per cent five days after being received, and they were far past a marketable condition. The carefully handled lots had a great advantage aside from their better and sounder condition, in that they were in fit shape to be reshipped from large centers to smaller surrounding towns, thus allowing a much wider distribution and extension of the market. The importance of this fact can best be appreciated when considered in connection with the problems of overproduction and the possibilities of increasing the sale and use of the fruit. As long as the commercial packs continue to arrive at or near the limit of decay commercially allowable, the possibilities of reshipment are extremely limited, and the market for the fruit is cut down accordingly.

In the careful-handling experiments with grapes and oranges nothing was attempted which can not be done under commercial conditions. In the case of citrus fruits the piecework system has been changed to the day-payment plan, thus doing away with the tendency to rapid and careless work. In the grape industry no such radical change is necessary, as the day-payment plan largely prevails, but the pickers, packers, and all those who handle the fruit must be impressed with the necessity of doing their several operations with the utmost care. The fault lies largely in requiring as much and as rapid work to be done in a day as possible. Nearly every grower knows or believes that care is necessary, but very few realize how much damage is really due to requiring their help to work at topmost speed in order to get the work done as cheaply as possible. In many instances growers are astounded when informed of the amount of injury which is done. In the hurry and anxiety to get off as much as possible and to hasten all operations the bruises, the scratches, and the punctures which result are too often overlooked.

Naturally it will cost more to handle the fruit carefully. At first sight it seems unreasonable to advocate spending more money in
preparing fruit for market during seasons of low prices, but it has been found to be good business policy to make the increased expenditure. The saving in the quantity of sound fruit gotten to market will alone very nearly balance the increased cost. Using the average percentages of decay in the carefully handled and the commercial packs of grapes already noted, the saving in favor of careful handling amounts to nearly forty-five crates per car, or a full carload of grapes for every twenty-one shipped, and this does not take into consideration the increase in market value and consequent salability of the sounder fruit, the price of fresh fruit being always depreciated by the presence of decay.

What has been found to be true in the grape industry applies with equal force to all other branches of fruit growing. Sound fruit of good quality, honestly and uniformly graded and packed, is the fundamental factor upon which the success of the business depends.

REFRIGERATION.

Another factor of prime importance in the successful shipping of fresh fruits long distances is quick and efficient refrigeration. The deciduous fruits are all shipped during warm weather and must be kept cool while in transit. The full transcontinental trip requires usually from twelve to fourteen days, which may be comparable to a period of about two weeks in cold storage.

As already stated, it has been found that the ripening processes are hastened when the fruit is picked. The development of molds also goes on at a rapid rate while the fruit is warm. Reducing the temperature retards the ripening and prevents the development of the molds. The length of time that the fruit will remain in good condition depends upon the promptness and the thoroughness with which it is cooled.

Careful records made of many deciduous-fruit packages show that the temperatures of the packed fruit during the greater part of the season are extremely high. The range runs from 80° to over 100° F., and the average of all temperature records made is between 90° and 95° F. At such temperatures the fruit ripens very fast and decay and deterioration are extremely rapid, especially if the fruit has been roughly handled and injured to any great extent.

Records made in refrigerator cars show that the rate of cooling in the fruit package is very slow when the ice of the car is depended upon both to reduce the temperature and to hold it low. It frequently happens that several days elapse before the fruit is cooled sufficiently to retard ripening and decay. This is the main reason why the Pacific-coast fruits are picked so long before they have acquired full quality. When they are not picked green, they become over-ripe and soften
before the ice of the car has a chance to reduce the temperature below the danger point.

Frequently a very distinct advantage may be gained by allowing the fruit to remain open overnight and packing while it is cool in the morning. More cooling can usually be obtained in this way than in one or two days in the refrigerator cars after the fruit is packed, especially where it is wrapped in paper. This is particularly true for grapes, and many growers and packers take advantage of it. It has been asserted that before a system of overnight cooling was adopted it was impossible to ship peaches and plums in sound condition from some of the interior points of the San Joaquin Valley of California.

During the last eight years the Bureau of Plant Industry has conducted investigations of different methods of quickly cooling fruits before shipping. This practice, which has for its object reducing the temperature as quickly as possible, has been designated "precooling." Under this system the ice of the refrigerator car is not expected to cool the fruit, but only to keep it cool during the trip across the continent.

Precooling is usually done by mechanical means after the fruit is packed, either in a warehouse or a cold-storage plant before loading on the cars or after loading by forcing large volumes of very cold air through the cars, thus reducing the temperature of the fruit much more rapidly than can be done with ice alone. Precooling may also be done before packing, and when this is practicable it is comparatively easy, because there is a chance for the circulation of the air around the fruit. The disadvantage of such a system is that the packing has to be done in cool rooms to avoid the condensation of moisture on the cold fruit.

The best system of precooling, whether in cars or in warehouses, has not yet been definitely determined, although two of the great transportation companies of the Pacific coast are erecting mammoth plants to precool in the cars all the fruit shipped over their lines. One great disadvantage of this system is the delay which must necessarily ensue in assembling the cars from the different districts. Much of the beneficial effect from precooling will be lost unless the work is done as soon as possible after the fruit is packed. A delay of even twelve hours during warm weather may very seriously affect the results.

Another disadvantage in car precooling is the great difficulty or impossibility of so distributing the air that every package will be reached. Under the best conditions some of the packages will be cooled very much more quickly than others, depending upon the method of applying the air.

Precooling in a warehouse or cool room consists in placing the fruit in a refrigerated room, with sufficient piping to keep the room tem-
perature well below the desired point until all the packages are thoroughly cooled. The packages may be so stacked that a thorough circulation is possible, resulting in greater uniformity in the cooling than is the case in the closely packed car.

One disadvantage of having the precooling done in warehouses is the expense of building and maintaining the necessary plants, and this must be borne by the shipping companies, growers’ associations, or individual growers. Under this system the expense and responsibility fall on the shipper, while under the car-precooling system the transportation companies bear the burden. However, the transportation companies must require that the fruit be delivered to them in sound condition and fit for shipment, and whether the placing of the packages in proper condition for safe shipment should include the reduction to a proper and safe temperature is an open question.

The advantages of precooling in the handling of deciduous fruits are manifold. The first and most important of these is the fact that, if pre cooled, the fruit may be left on the trees to attain a greater degree of maturity, thus assuring a much better quality. It has been shown that the soft fruits, like plums, peaches, and apricots, may be allowed to remain until they reach a hard-ripe condition and may then be shipped long distances without deterioration. Plate XXIX, upper figure, illustrates an Early Crawford peach that was allowed to reach the hard-ripe stage before picking, which, by being pre cooled, was shipped to New York in sound condition. Plate XXIX, lower figure, illustrates the condition of peaches shipped commercially at the same time. In both cases the illustration shows the condition of the fruit on arrival at its destination. In the case of cherries and berries, precooling will enable the crop to be shipped greater distances, thus assuring wider market distribution and more satisfactory condition on arrival.

Precooling is now recognized as one of the important factors in the safe shipping and handling of highly perishable products, and its use will be extended as its advantages and application are better understood. It should never be used as a means to overcome difficulties arising from improper or rough handling. Used as a means to insure safe shipment after the grower and packer have done their share, precooling is both valuable and legitimate. Used as a means to overcome the effects of rough handling, precooling only retards decay and deterioration for a time, and the troubles develop when the fruit warms up after arrival in the market.