(coldest) pint and the last (hottest) pint. This shows that care must be taken when choosing a fruit to measure the temperature to determine when cooling is completed. In some packinghouses, the operators use the fruit on top of the first basket to gage the degree of cooling because it is the most readily accessible fruit. Table 5 shows the temperature gradient in the strawberries when the top fruit of the first basket has reached 7/8 cooling. A temperature difference of 4°C (7.2°F) exists between the top fruit and the average temperature of basket 1, and 11°C (19.8°F) exists between the top fruit and the average temperature of basket 9.

Room cooling, storage, and shipping

The simplest and slowest cooling method is room cooling, in which the bulk or containerized commodity is placed in a refrigerated room for several hours or days. Air is circulated by the existing fans from the evaporator coil in the room. Vented containers and proper stacking are critical to minimize obstructions to air flow and ensure optimal heat removal. Room cooling alone is satisfactory only for commodities with a low respiration rate, such as mature potatoes and onions. For strawberries it should be used only after precooling for 7/8-cooling time, during short-period storage prior to shipment. Refrigerated trucks should be precooled prior to loading the precooled strawberries. After precooling, top icing of strawberries is not desirable during holding or transport.

Modified atmosphere

Refrigeration is sometimes supplemented with modified atmosphere during transit or storage. With solid loads, the modified atmosphere may be established for the entire transport vehicle. Plastic shrouds are, more commonly, placed over individual pallets equipped with a base that can be sealed. Pallet bags are installed after cooling, usually just before loading for transport. Carbon dioxide (CO_2) is then injected into the package to establish the desired atmosphere. Elevated levels of carbon dioxide (10 to 30%) slow the respiration rate of the fruit and reduce the activity of decay causing organisms, thus extending storage and market life. Carbon dioxide atmospheres of 30% or greater can cause off-flavor. Recent studies [4] indicated that carbon dioxide treatment was of little benefit when storage temperatures were maintained below 5°C (41°F). Therefore, if transit and storage temperatures are maintained below about 2.2°C (36°F) there is little need for the carbon dioxide treatment. Practically speaking, considerable evidence indicates that strawberries are often exposed to temperatures above 4.4°C (40°F) during transport and in these cases the carbon dioxide treatments may be beneficial.

Management guidelines

The following management guidelines or recommendations summarize the important post-harvest information discussed above.

Strawberries should be handled gently at all times to maintain quality since they are so easily bruised. Bruised berries are very susceptible to decay. Anytime a fruit is bruised, the bruised area will discolor. In addition, bruising increases water loss. Only sound fruit should be shipped, because decay fungi can easily spread throughout each shipping container. Berries without stem caps are particularly perishable. Strict grading should eliminate out-of-grade berries. It important to acknowledge that while proper post-harvest cooling and handling techniques can help maintain product quality, the quality packed can never be improved.

Flats should not be overfilled because stacking will cause crushing. After packing, strawberries should be kept in the shade and transported to the cooler as soon as possible. The temperature of harvested strawberries in the field can get up to 30°C (86°F), and higher when exposed to sun; and when fruits are allowed to remain at this temperature for 4 hours, marketability drops by at least 40%. Again, very careful handling of the packed strawberries is essential to maintaining quality.

A well-designed forced-air cooler should be maintained at a constant temperature near 0°C (32°F). As noted above, the air flow rate has a definite effect on the cooling rate of strawberries in cartons and new vent hole designs can improve cooling efficiency. A cooling schedule should be developed for the forced-air cooler to maximize efficiency. Use of a schedule allows cooling times to be adjusted based on the initial temperature of the berries and prevents inadequate or excessive precooling resident time.

Temperatures should be measured with a reliable electronic thermometer. Fruit pulp temperatures should be taken prior to precooling and during precooling. Fruit temperatures should be measured on the warm side of the cooler (inside of stack in systems that draw air through the berries; outside of stack in system which blow air through the berries). Care should be taken in sampling the strawberry temperatures to determine when