Temperature management is essential for maintaining produce quality.

by Jenny Jobling

This is the first in a series of articles looking at the postharvest temperature management of fresh produce. The first part looks at how and why temperature affects the quality of fresh fruit, vegetables and flowers. The following parts of this series will discuss how temperature can be managed by growers and handlers of fresh produce.

Temperature management is one of the most important factors affecting the quality of fresh produce. There is an optimum storage temperature for all products. There are many references which outline the optimum temperature for a range of fresh product. Some examples are listed at the end of the article.

The ideal temperature often depends on the geographic origin of the product. Tropical plants have evolved in warmer climates and therefore cannot tolerate low temperatures during storage. Plants from tropical origins must be stored above 12°C. This is in contrast to plants which have evolved in temperate, cooler climates which can be stored at 0°C. Table 1 gives a few examples of products and their recommended storage temperature.

Table 1: Recommended storage temperatures for a selection of fruit and vegetables.

<table>
<thead>
<tr>
<th>1 - 4 °C</th>
<th>5 - 9 °C</th>
<th>10 °C+</th>
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<tbody>
<tr>
<td>Apple</td>
<td>Avocado</td>
<td>Avocado</td>
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<tr>
<td>(temperate</td>
<td>(temperate</td>
<td>(sub tropical)</td>
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<tr>
<td>origin)</td>
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<td>Asparagus</td>
<td>Zucchini</td>
<td>Pawpaw</td>
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<tr>
<td>Berry fruits</td>
<td>Bean (French)</td>
<td>Grapefruit, lemon</td>
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<td>Broccoli</td>
<td>Passionfruit</td>
<td>Mango</td>
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<tr>
<td>Peach, plum</td>
<td>Eggplant</td>
<td>Banana</td>
</tr>
<tr>
<td>Cherry</td>
<td>Capsicum</td>
<td>Pineapple</td>
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<tr>
<td>Grape</td>
<td>Cucumber</td>
<td>Sweet potato</td>
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<tr>
<td>Lettuce</td>
<td>Mandarin, orange</td>
<td>Tomato (mature green)</td>
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<tr>
<td>Mushroom</td>
<td>Potato</td>
<td>Pumpkin</td>
</tr>
<tr>
<td>Carnation</td>
<td>Protea</td>
<td>Ginger</td>
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Metabolism and shelf life

Growing plants have only a limited capacity to maintain a constant internal temperature. The main means of cooling is by water loss via transpiration. During very hot conditions plants “cool down” by allowing water to evaporate.
from their leaves. The change in state from liquid to a gas absorbs heat energy and so the temperature near the leaves is less than the surrounding air. This means that on warm days plants use a lot of water, most of which is used for cooling.

Once fruit, vegetables or flowers are harvested they are no longer attached to their root system. Therefore any water that is lost, can now no longer be replaced by its roots. This is why rapid cooling after harvest is so important. If the temperature is lowered and the harvested products are put in refrigerated storage, water and quality loss can be reduced.

Fresh produce is alive, living and breathing. The general term for all the processes going on inside a living organism is called metabolism. Temperature has a big effect on the rate of metabolism of the product. When the temperature of the product rises, so too does the rate of metabolism. One of the main processes of metabolism is respiration which is the process of breaking down stored carbohydrate to produce energy. This means that when the temperature rises in products which do not have a lot of stored reserves, such as leafy vegetables and flowers, carbohydrate can become limiting. More simply, they run out of food and as a result the shelf life and quality is rapidly reduced by warm temperatures. Since the produce is separated from the rest of the plant these food reserves cannot be replaced.

Temperature management for fresh produce is the key to quality. Lowering the temperature as quickly as possible after harvest will slow the rate of metabolism and therefore extend the product’s shelf life. For some flowers, sugar can be added (always with a biocide) to the vase solution to provide carbohydrate, or food for metabolism. As a result, for these types of produce respiration is not limited and the vase life is extended.

At extremes of temperature, products are damaged. Some suffer chilling injury, some suffer damage at very high temperatures and all products are damaged if they freeze.
Damaging effects of high temperatures

High temperatures usually result from exposure to either direct sunlight, hot air in the field or heat treatments used for the eradication of pests. Some examples include not removing the field heat from harvested products, leaving harvested product in the direct sunlight or a breakdown of refrigeration and lack of air circulation. The temperature is also increased by the heat generated by the product itself. As the product respires it produces heat and if the products are packed in a way that prevents air circulation then the heat can build up considerably. If the temperature increases, so does the rate of metabolism and as a result shelf life is shortened.

However at extreme temperatures other problems can also arise. For example some enzymes which keep the plant functioning slow down at temperatures above 30 °C and cease operating at 40 °C. This results in high temperature injury. The consequences are a general loss of pigment or colour and effected areas develop a watery appearance and appear translucent. This is sometimes referred to as ‘boiled’ when it is seen in tomatoes and bananas. Another example of high temperature injury is when tomatoes appear orange. This occurs because the formation of the normal red colour has been disrupted by periods of high temperature often on the shoulders from sunburn.

Damaging effects of low temperatures

Low temperatures can be equally damaging. Low temperature injury might result from transport in cold regions or from a tropical region to a temperate region, an incorrect thermostat setting, breakdown in refrigeration or a lack of circulation in a refrigerated store.

There are two types of cold temperature injury, freezing injury and chilling injury. Freezing injury occurs when the contents of the cells freezes. This occurs at temperatures below 0 °C because the sugars and other compounds within the cells of the plants. Leafy vegetables don’t have as many dissolved sugars as fruit do and so leafy vegetables will freeze at -0.5 °C and sweet fruits will freeze between -2 and -5 °C. The symptoms of freezing injury are water soaked damaged areas.

Chilling injury is the most common form of injury. Subtropical and tropical commodities are especially susceptible to chilling injury. The extent of chilling injury is the result of three factors; Sensitivity of the crop, the temperature and the duration of exposure.

If sensitive crops are exposed to low temperatures for short periods, up to a few hours then the product can repair the damage and so symptoms do not appear. However if the exposure time causes severe damage then symptoms will develop. Examples of the symptoms of chilling injury include, an increased susceptibility to rots, loss of water and shrivelling, rusty, grey or brown discolouration (common symptom for bananas) and black pitting of the skin.

Chilling injury can also makes stored produce more susceptible to postharvest rots. Beans will get brown spots and soft rots, zucchinis, tomatoes, cucumbers and aubergines are also more susceptible to rots. These products are often stored in the home refrigerator and if not used in a short time are thrown out as a result of chilling injury induced rots. Sometimes chilling injury can take a long time to cause an effect. For example chilling injury of citrus can take up to several weeks to fully develop. The symptoms are dry areas in the flesh of the fruit. Chilled citrus fruit can be harvested and processed or sold promptly locally without any quality problems. However if the fruit are left in storage
for several weeks and then sold the symptoms will be more obvious. Black heart in pineapples is also a problem which is the result of chilling injury. It is most likely to occur during the winter growing seasons when the night temperatures fall below 12 °C.

It is important to remember that even short exposures, a few hours to extreme hot or cold temperatures can cause a marked decrease in shelf life and loss of quality. Often the symptoms of the injury do not appear straight away and it may be the consumer who suffers with mealy stonefruit or poorly ripened tomatoes. Correct and careful temperature management throughout harvest and marketing chain is essential if the quality of the product is to be assured.

References


*Optimal Fresh* (2000). A new CD computer database which is shortly to be released by CSIRO publishing.

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