Harvesting and Postharvest Technology of Vegetables

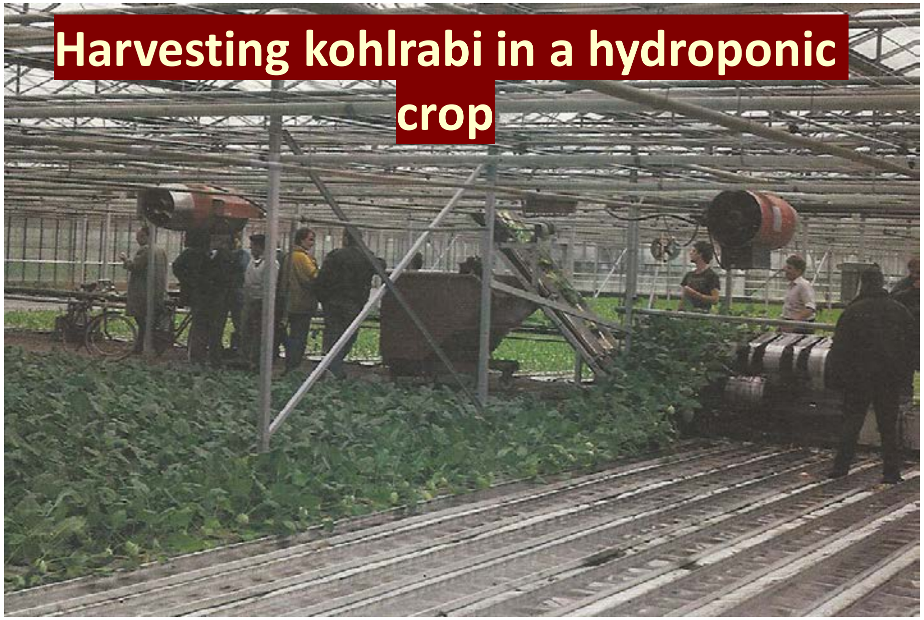
Maintaining quality of vegetables after harvesting

- Appropriate production practices, careful harvesting, and proper packaging, storage, and transport all contribute to good produce quality after harvesting.
- Quality cannot be improved after harvest, only maintained.
- Therefore it is important to harvest fruits, vegetables, and flowers at the proper stage and size and at peak quality.
- Immature or overmature produce may not last as long in storage as that picked at proper maturity.

Harvesting

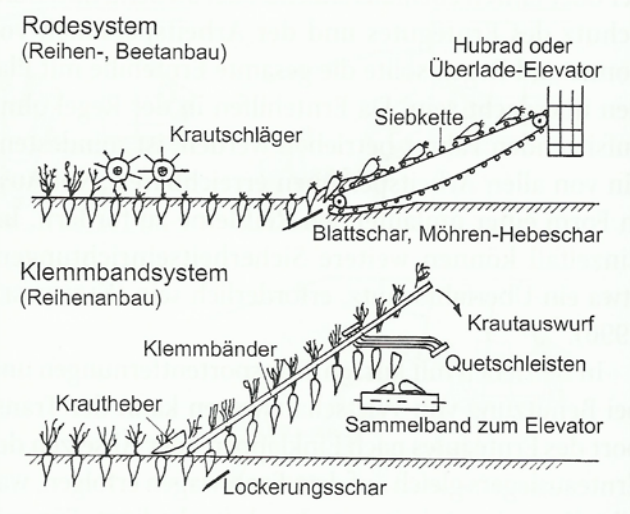

Harvesting potato

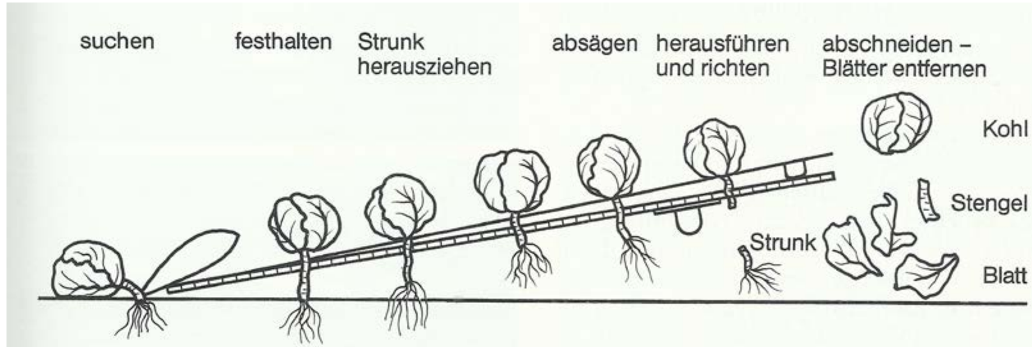

Harvesting lettuce

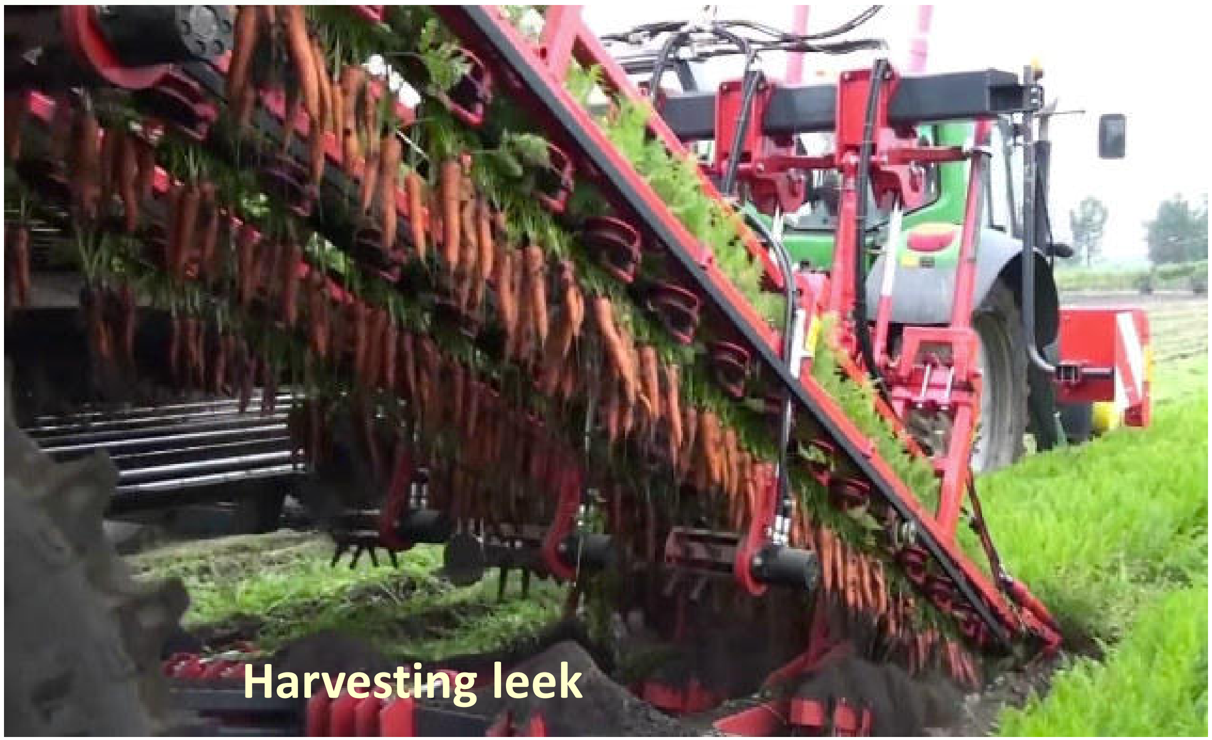

Harvesting kohlrabi in a hydroponic crop


Transport of harvested greenhouse tomato

Mechanical harvesting of root vegetables







Other harvesting practices

Principles of harvesting

- Harvest should be completed during the coolest time of the day, which is usually in the early morning, and produce should be kept shaded in the field.

- The produce has to be handled gently.

- Crops destined for storage should be as free as possible from skin breaks, bruises, spots, rots, decay, and other deterioration.

- Bruises and other mechanical damage not only affect appearance, but provide entrance to decay organisms as well.

Packaging of vegetables after harvesting

Harvesting and packaging in situ

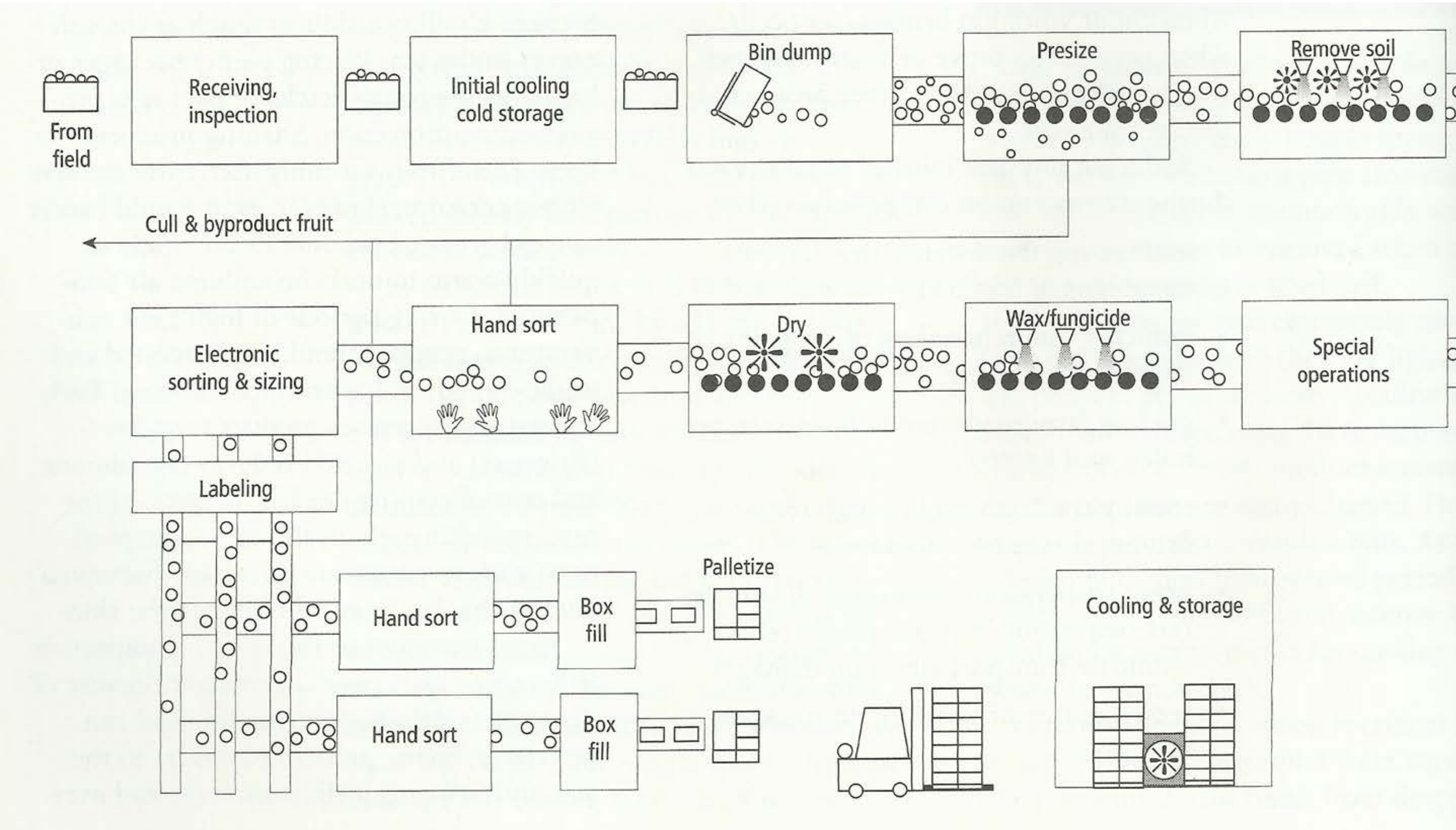
Packaging should be designed to prevent physical damage to produce, and be easy to handle.

Packaging in a packing house

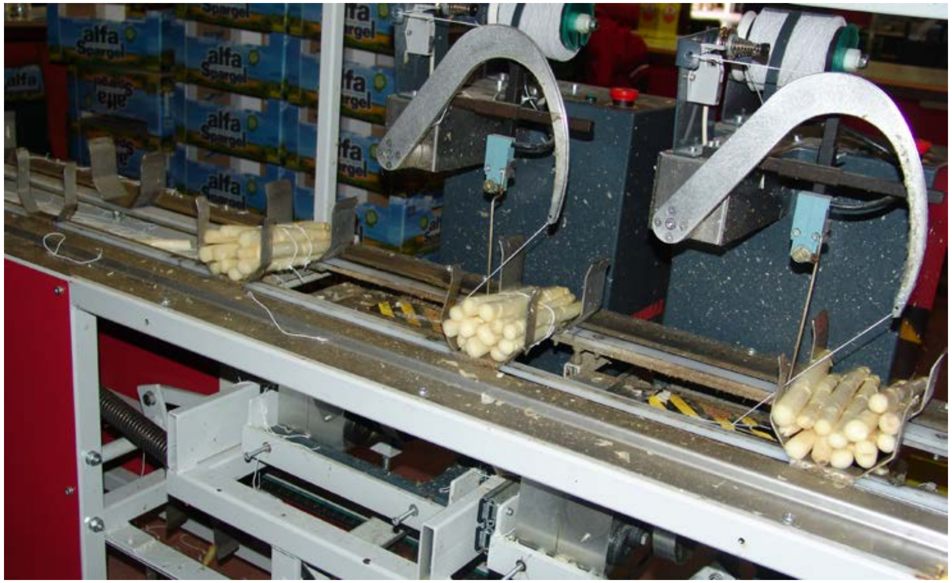
Grading of vegetable products

1. **Grading in weight classes**
2. **Grading in size classes mechanically**
3. **Grading in size classes through electronic imaging**

Packing line



Packaging materials & methods



Micropackaging

Fresh-cut salads

Post-harvest storage

Vegetables are marketable as long as they maintain their quality to a level that is acceptable by consumers.

Thus, post-harvest storage technologies are aimed at maintaining the quality of vegetables as long as possible.

Impact of temperature on post-harvest life of vegetables

Temperature is the single most important factor in maintaining quality after harvest.

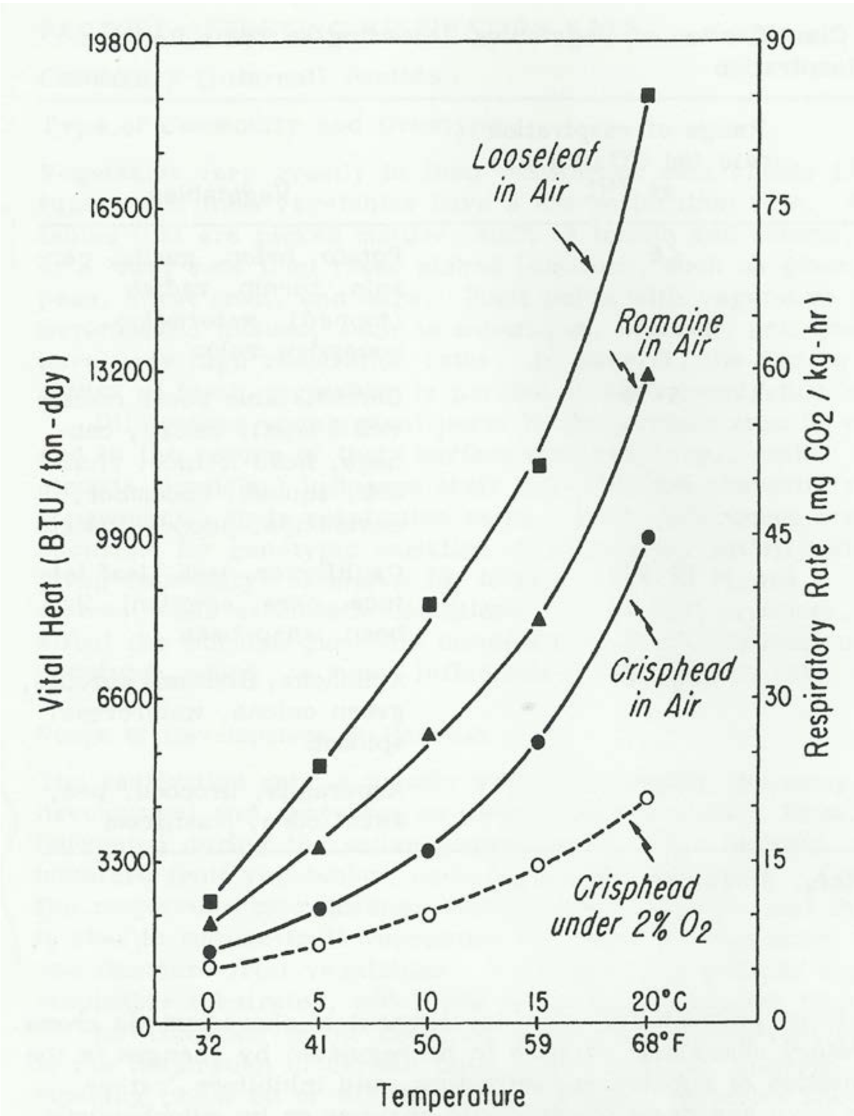
Refrigerated storage retards the following elements of deterioration in perishable crops:

- aging due to ripening, softening, and textural and color changes;
- undesirable metabolic changes and respiratory heat production;
- moisture loss and the resultant wilting;
- spoilage due to invasion by bacteria, fungi, and yeasts;
- undesirable growth, such as sprouting of potatoes

Impact of storage temperature on respiration rate

- **One of the most important functions of refrigeration is to control the crop's respiration rate.**
- **Respiration generates heat as sugars, fats, and proteins in the cells of the crop are oxidized.**
- **The loss of these stored food reserves through respiration means decreased food value, loss of flavor, loss of salable weight, and more rapid deterioration.**
- **The respiration rate of a product strongly determines its transit and postharvest life.**
- **The higher the storage temperature, the higher the respiration rate will be.**

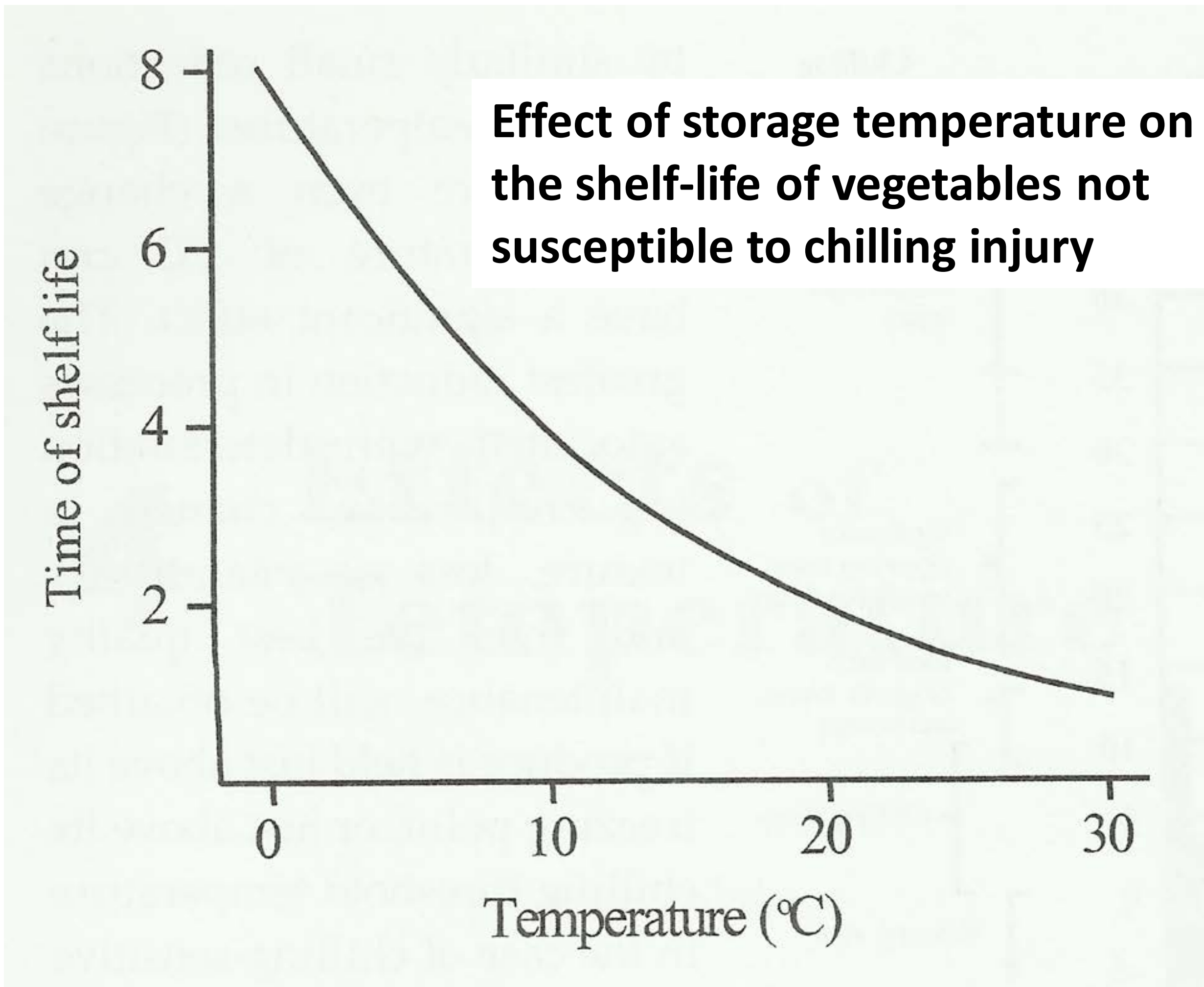
Impact of temperature on respiration rate and heat production



Different genotypes may exhibit large differences in respiration rates at the same temperature

Reducing the O2 concentration in the storage atmosphere results in a strong reduction of the respiration rate

Impact of storage temperature on shelf-life of vegetables



Pre-cooling

Pre-cooling is the first step in good temperature management.

The field heat of a freshly harvested crop (heat the product holds from the sun and ambient temperature) is usually high, and should be removed as quickly as possible before shipping, processing, or storage.

Most refrigerated storage rooms have neither the refrigeration capacity nor the air movement needed for rapid cooling.

Therefore, pre-cooling is generally a separate operation requiring special equipment and/or rooms.

Importance of pre-cooling for different vegetable species

Rapid pre-cooling to the product’s lowest safe temperature is most critical for crops with inherently high respiration rates.

These include artichokes, brussels sprouts, cut flowers, green onions, snap beans, asparagus, broccoli, strawberries, and sweet corn.

Vegetables with low respiration rates include garlic, onions, potatoes (mature), and sweet potatoes

Most common methods of pre-cooling
1. Room cooling

Produce is placed in an insulated room equipped with refrigeration units.

This method can be used with most commodities, but is slow compared with other options.

A room used only to store previously cooled produce requires a relatively small refrigeration unit.

However, if it is used to cool produce, a larger unit is needed.

Containers should be stacked so that cold air can move around them, and constructed so that it can move through them.

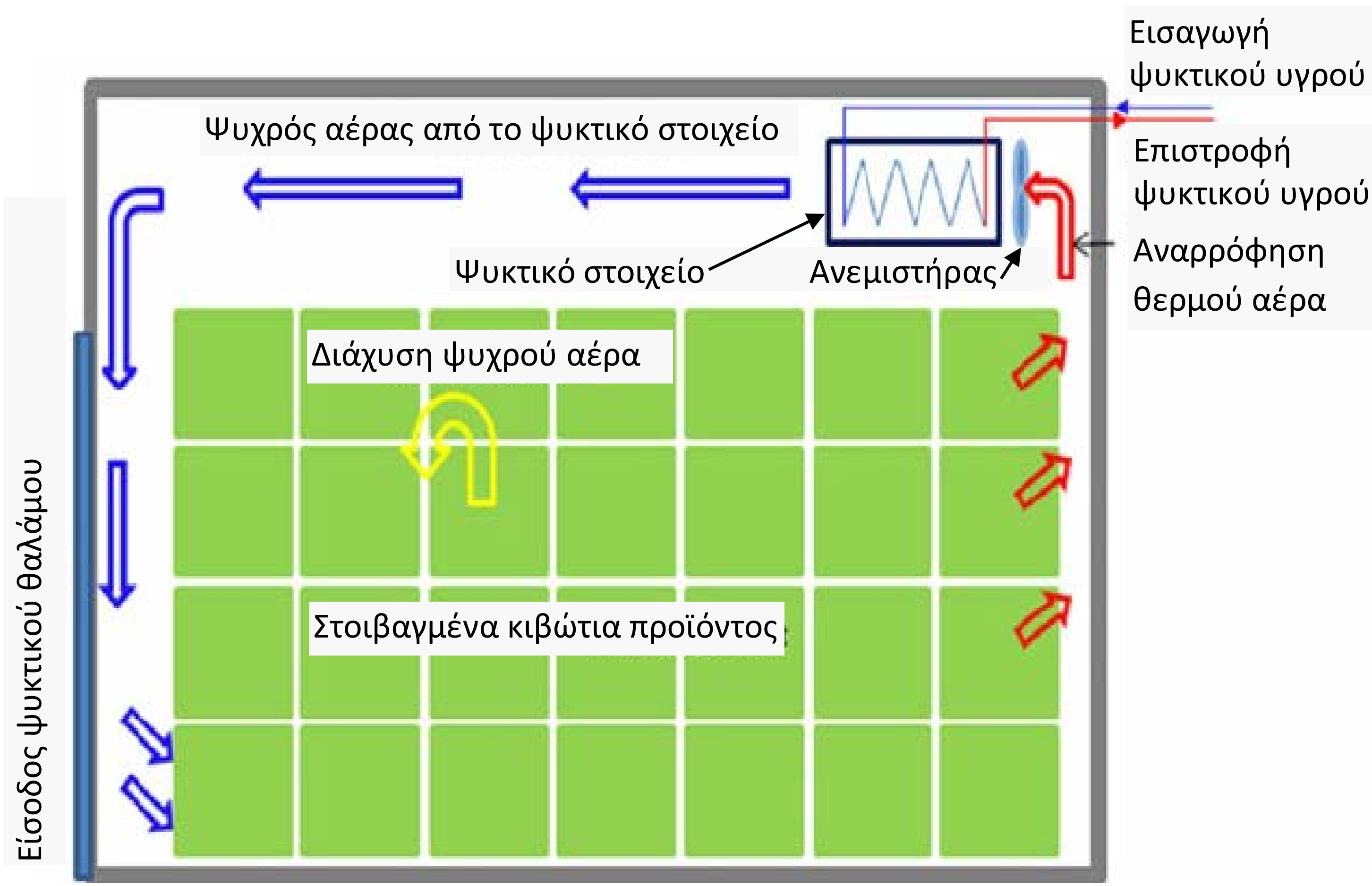
Most common methods of pre-cooling
2. Forced-air cooling

- Fans are used in conjunction with a cooling room to pull cool air through packages of produce.

- Although the cooling rate depends on the air temperature and the rate of air flow, this method is usually 75–90% faster than room cooling.

- Fans should be equipped with a thermostat that automatically shuts them off as soon as the desired product temperature is reached.

Schematic representation of a forced-air cooling facility



Most common methods of pre-cooling
3. Hydro cooling

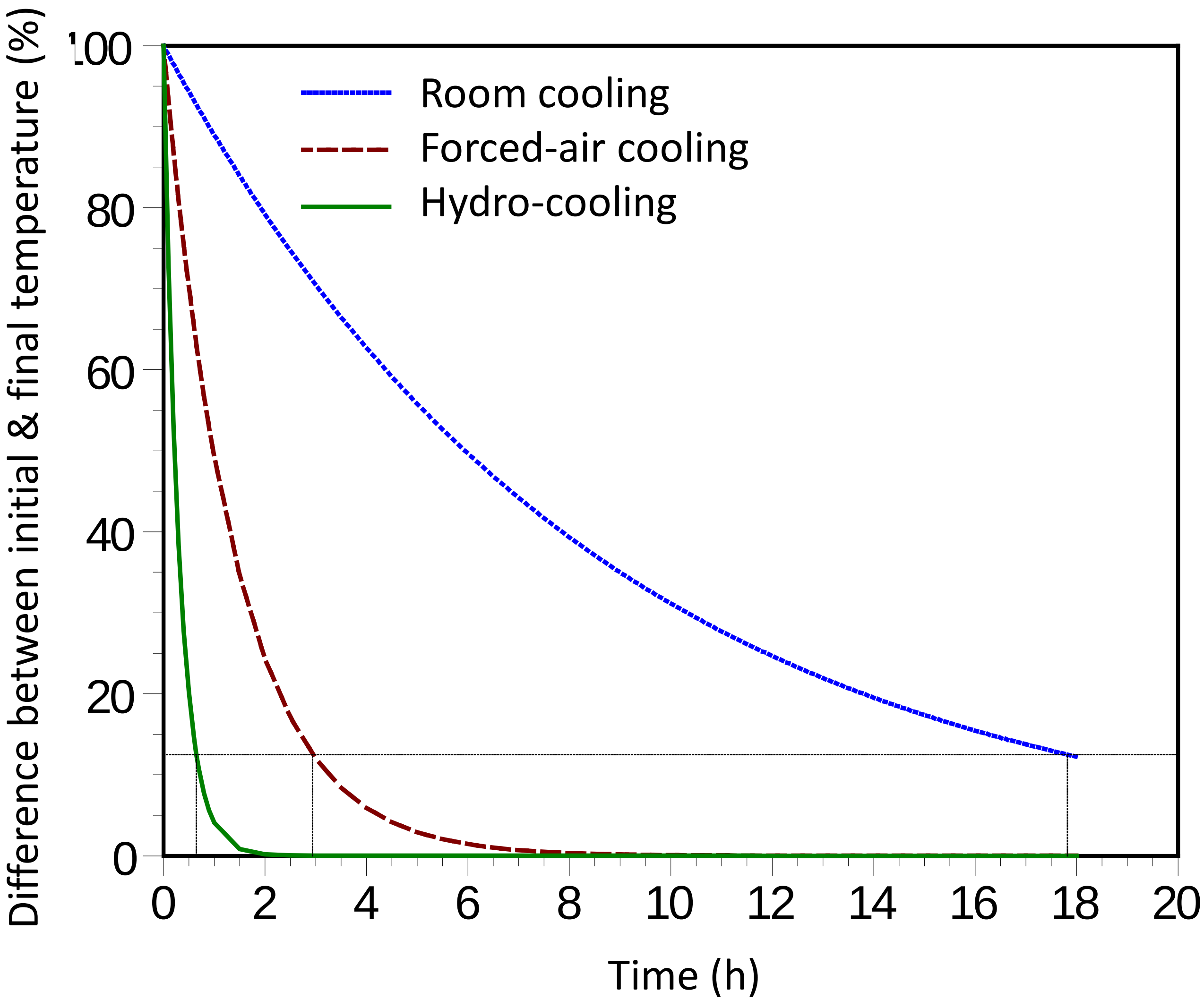
Hydro-cooling: Dumping produce into cold water, or running cold water over produce, is an efficient way to remove heat, and can serve as a means of cleaning at the same time.

n addition, hydro-cooling reduces water loss and wilting. Use of a disinfectant in the water is recommended to reduce the spread of diseases.

Hydro-cooling is not appropriate for berries, potatoes to be stored, sweet potatoes, bulb onions, garlic, or other commodities that cannot tolerate wetting.

Hydro-cooling facility

Impact of pre-cooling method on the time needed to achieve the target low temperature



Most commonly methods of pre-cooling
4. Top or liquid icing

- Icing is particularly effective on dense products and palletized packages that are difficult to cool with forced air.

- In top icing, crushed ice is added to the container over the top of the produce by hand or machine.

- For liquid icing, a slurry of water and ice is injected into produce packages through vents or handholds without removing the packages from pallets and opening their tops.

- Icing methods work well with high-respiration commodities such as sweet corn and broccoli.

Most commonly methods of pre-cooling
5. Vacuum cooling

Produce is enclosed in a chamber in which a vacuum is created.

As the vacuum pressure increases, water within the plant evaporates and removes heat from the tissues.

This system works best for leafy crops, such as lettuce, which have a high surface-to-volume ratio.

To reduce water loss, water is sometimes sprayed on the produce prior to placing itin the chamber.

The primary drawback to vacuum cooling is the cost of the vacuum chamber system.

Chilling injury

- Many vegetables and fruits store best at temperatures just above freezing, while others are injured by low temperatures and will store best at 13 to 17 ^{o}C.

- Both time and temperature are involved in chilling injury.

- Damage may occur in a short time if temperatures are considerably below the danger threshold, while some crops can withstand temperatures a few degrees into the danger zone for a longer time.

Occurrence of chilling injury

Vegetables susceptible to chilling injury may look sound when removed from low temperature storage.

However, after a few days of warmer temperatures, chilling symptoms become evident:

- pitting or other skin blemishes,
- Internal discoloration,
- failure to ripen.

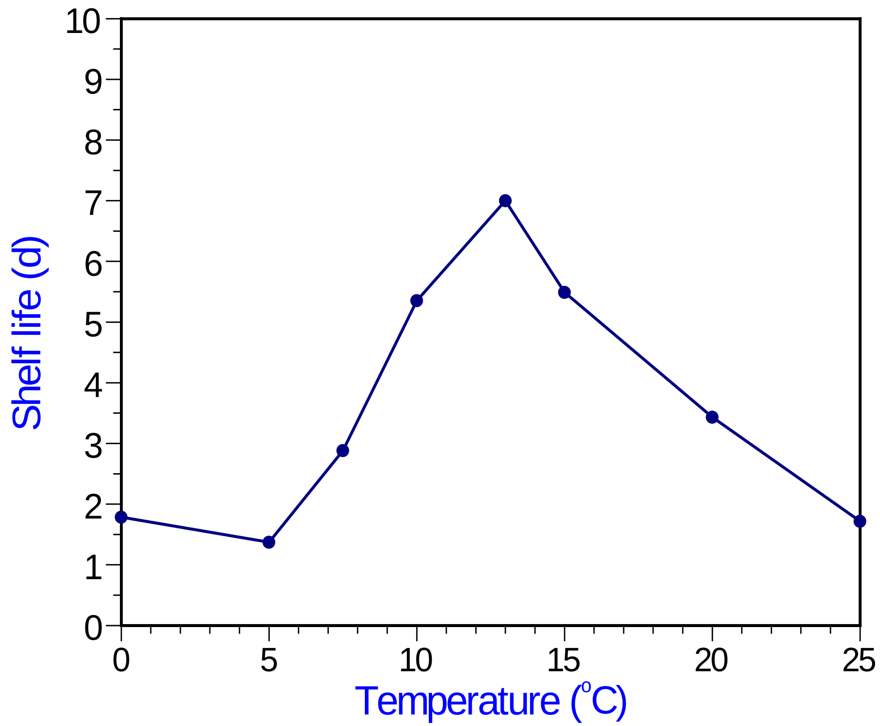
Tomatoes with symptoms of chilling injury

Vegetables susceptible to chilling injury

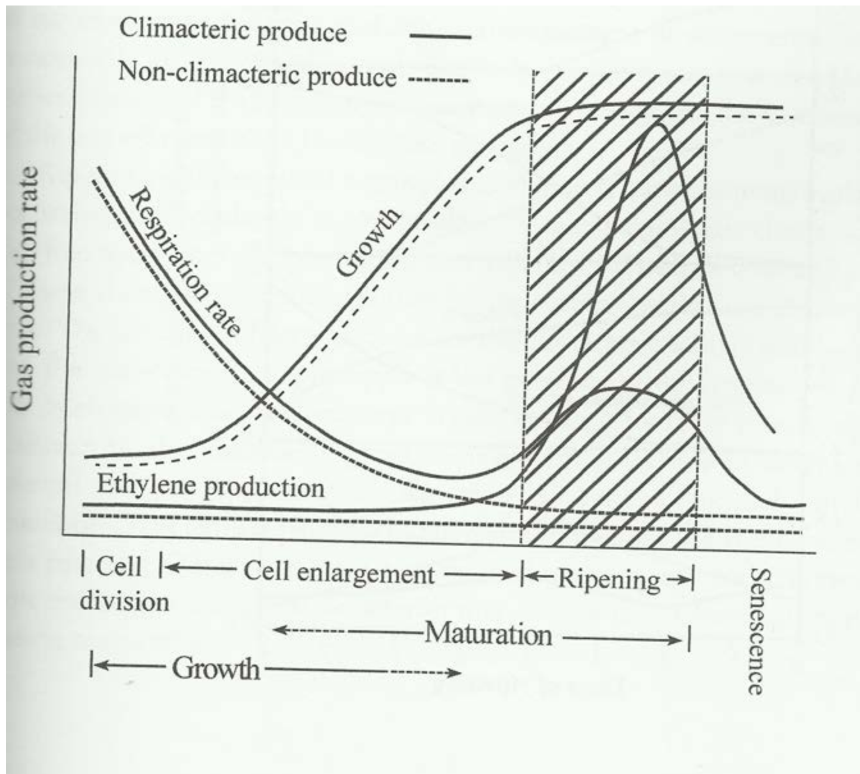
Crops such as cucumbers, eggplants, pumpkins, summer squash, okra, and sweet potatoes are highly sensitive to chilling injury.

Moderately sensitive crops are snap beans, muskmelons, peppers, winter squash, tomatoes, and watermelons.

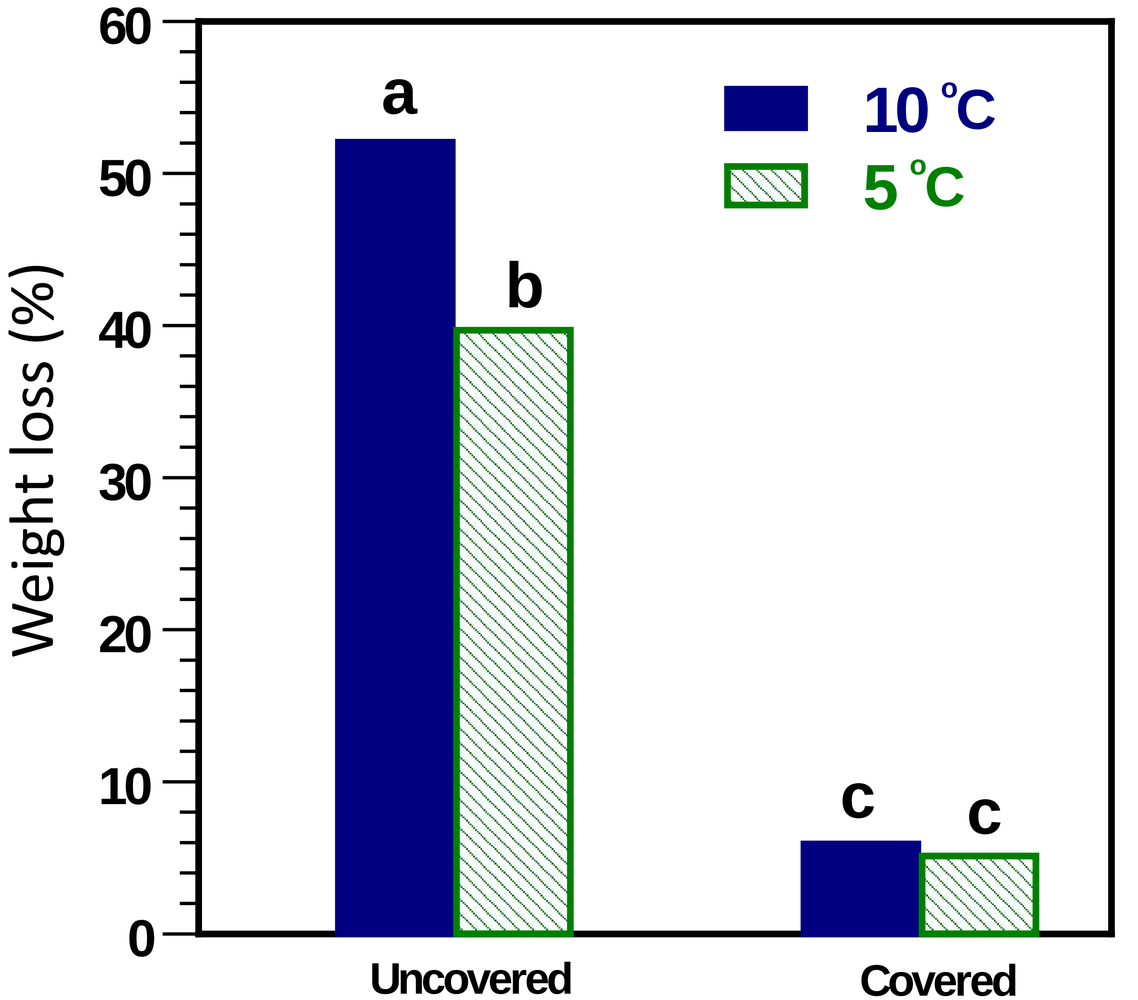
Tomatoes, summer squash, and peppers that have been over-chilled may be particularly susceptible to decay caused by *Alternaria* rot.



Climacteric fruit vegetables



Weight loss (owing to water loss) in zucchini fruit stored for 2 weeks at 10 °C or 5 °C, uncovered or covered by polyethylene film.



Preventing moisture loss

While temperature is the primary concern in the storage of vegetables, relative humidity is also important.

The relative humidity of the storage unit directly influences water loss in produce.

Water loss can severely degrade quality resulting in a wilt appearance of the produce.

Water loss means salable weight loss and reduced profit.

Most fruit and vegetable crops retain better quality at high relative humidity (80 to 95%), but at this humidity, disease growth is encouraged.

Adjustment of relative humidity in storage rooms of vegetables

The cool temperatures in storage rooms help to reduce disease growth, but sanitation and other preventative methods are also required.

Maintaining high relative humidity in storage is complicated by the fact that refrigeration removes moisture.

Humidification devices such as spinning disc aspirators may be used.

Other aspects related to postharvest storage of vegetables

- **Sanitation:** Important to avoid infections by pathogens
- **Ethylene:** A plant hormone that accelerates the ripening process thereby reducing postharvest life
- **Modified atmosphere (MA).** Reduction of O_2 and increase of CO_2 concentration in the storage room
- **Controlled atmosphere (CA).** Controlled modification of O_2 (reduction) and CO_2 (increase) concentrations in the storage room