COOL PRODUCE

COOLING OPTIONS FOR MARKET GARDENS

*By Rupert Jannasch**

Some years ago, a Nova Scotia farmer caused a stir by insisting that organic produce had a shorter shelf life than conventional. A spirited debate was resolved with an agreement that quality reflects shoddy product handling after harvest as much as the method of production.

Cooling is by far the most important post-harvest handling technique for market gardeners. Other measures, such as avoiding bruising, harvesting fruit and vegetables when dry, and overall cleanliness, help maintain quality, but by far the easiest way to protect your investment is to swiftly reduce the product's field temperature.

There is a rule of thumb that every hour lost before cooling to the optimal storage temperature reduces the shelf life of a vegetable or fruit by about one day. Unfortunately, much of the published literature on post-harvest handling promotes a sledgehammer approach to cooling that advocates lowering a product's temperature as fast and low as possible without causing chilling injury. Typically, however, the recommended equipment, such as walk-in coolers, ice machines and vacuum cooling units, are a poor fit for many organic market gardeners. The high purchase, installation and maintenance costs of a refrigeration system are uneconomical for small-scale operations. This article will explore some low-cost alternatives for cooling and storing produce.

Quality factors before harvest

A number of pre-harvest management factors can affect the afterlife of a vegetable or berry. Excessive irrigation and high plant densities in strawberries, for example, will hasten the onset of moulds which cause fruit rot. With many vegetables, high levels of soil nitrogen combined with irrigation produces tender and succulent plant tissue very prone to attack by aphids and the diseases they transmit. Improper manure use, especially on leafy vegetables, and contaminated irrigation water also affect the storability and safety of produce.

Working with shade

Field heat is the heat stored in a crop standing in the field. It is important to remove this heat as quickly as possible after harvest to restrict plant respiration. An easy way to minimize field heat is to harvest in the morning, the coolest part of the day.

Working in shade or placing harvested produce under shade will prevent field heat from increasing after harvest. Shade can also aid the cooling process.

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Dr. Robert Prange, a post-harvest handling expert with Agriculture and Agrifood Canada in Kentville, Nova Scotia, remembers visiting a blueberry grower using an innovative shading technique in the field. "This fellow had a wagon with a slatted floor," recalls Prange, "covered by a wide roof with a ridge vent. There was a large amount of shade underneath and the hot air rising through the vent pulled the cool air through the slatted floor." It made an excellent and inexpensive packing facility, says Prange, by immediately helping reduce the berries' field heat besides making conditions more comfortable for workers inside.

* With thanks to Marcus Casson for his valuable feedback on the article.

Cooling produce is an exercise in temperature management. The first step is removing field heat and the second is maintaining a suitable storage temperature. The removal of field heat will be extremely slow in large, confined and poorly ventilated spaces with a great deal of air space. Most walk-in coolers, for example, are very inefficient at removing field heat. That is why large-scale produce growers rely on hydro-cooling, vacuum cooling and ice to remove field heat. Refrigerated trucks are designed to maintain product temperature, not reduce it.

Dr. Robert Prange says, regardless of the scale of operations, "The first thing growers should do is invest in a good thermometer. It should be calibrated, especially if it is electronic, in ice water which is 32°F (0°C). This is a cheap investment and growers can look around [and poke into] their product and get feedback all on their own."

Evaporative cooling

Another inexpensive method of cooling for a packing house situation is evaporative cooling. Passive or forced air passing through a wetted material, such as burlap or excelsior (type of wood shavings designed for packing), will be cooled by the evaporation of water. Typically used in hot climates like Australia to protect dairy products or freshly slaughtered meat, evaporation is an energy-free process that can easily be applied in more temperate climates across Canada.

Water or hydro-cooling

Water is a useful cooling medium because it absorbs heat more efficiently than air. Some vegetables, such as asparagus, snap beans, broccoli, cauliflower, corn, cucumbers, lettuce, peas, spinach and tomatoes, can be hydro-cooled simply by dunking them in water. A water spray will help cool a crop like lettuce, keeping it crisp and clean it in the bargain. Water sources should be tested regularly for contaminants.

A water source that is naturally cool, such as that from a drilled well, works best. Otherwise, refrigeration can be used to cool water first, perhaps with a used bulk milk tank, even though that will ratchet up electricity costs.

A technique that works well with spinach is to wash it in cold water and stuff some gently in a clean pillow case. Spin it in a Hoover spin dryer for a minute or so and out comes clean, dry spinach.

Many of the techniques mentioned here are really pre-cooling techniques used prior to placing produce in a cool storage space. Numerous resources (see box on page 31) describe the storage needs of different crops. Consider the following storage requirements for each crop you store:

i) expected storage life or degree of perishability,
ii) temperature,
iii) relative humidity,
iv) sensitivity to chilling injury, and
v) sensitivity to ethylene (see box on page 30).

Storage temperatures for some crops may be overstated. For example, the optimum storage temperature for blueberries is often listed as just above freezing. This is fine for longer term storage, but has little relevance for growers planning to sell their berries at a farmers' market the next day. "Small-scale on-farm cold storages" (see Resources at end of article) lists temperatures for both long and short-term storage. These may differ by between 5 and 15 degrees, depending on the fruit or vegetable.

Cooling below ground

Any cooling and storage area will work better if it is below ground. One reason root cellars work well is that temperature fluctuations are minimal.

However, beware of basements. Cellars often appear attractive because they are generally large, dark and cool, but usually they have one critical drawback. Stairs. Lugging produce up and down stairs is awkward, dangerous and incredibly hard on the body, especially when dog tired. Unless they can be accessed by a hand truck or other wheeled device, basement storages should be avoided except in temporary circumstances for small quantities of lightweight produce.

Fridges, freezers and air conditioners

Refrigerators are generally inefficient cooling units, especially commercial types with glass doors. These units are powerful but poorly insulated. Furthermore, most of the cool air escapes when the vertical doors are opened. These machines can be useful at markets where product display is important, but they are extremely expensive to operate.

The ethylene problem

A large variety of fruits and vegetables and even some flowers are sensitive to ethylene, a natural hormone produced by some fruits as part of the ripening process. Apart from enhanced ripening of fruits, such as tomatoes, ethylene can cause changes in colour, flavour and firmness in a variety of produce types. Even the exhaust from natural-gas-powered forklifts contains enough ethylene to affect sensitive crops.

Producers must take great care not to mix ethylene producers, such as apples, melons, peaches, pears, plums and tomatoes, with the huge range of ethylene-sensitive crops. Dr. Robert Prange suggest that if growers are having quality problems in storage, such as yellowing of broccoli, they should check temperature control first and then consider the possibility of ethylene damage.

Alternatively, chest freezers can be turned into refrigeration units by replacing the temperature control with a rheostat (like a dimmer switch) from discarded refrigerators.

Used insulated truck bodies or containers are good options for on-farm storage. These boxes, however, tend to be large and growers should make sure they match the scale of their production. It is more efficient to keep cool a small space full of produce than a large, half-empty space.

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A portable cooler designed by the USDA is described in Postharvest Handling of Fruits and Vegetables (www.attra.org/attra-pub/postharvest.html). It is designed to fit in the back of a full-size half ton truck and run from a portable gas generator or electrical outlet.

Air conditioners provide a modest cooling capacity since they usually do not operate below 60°F (15°C). Their main disadvantage is causing desiccation (drying out) of produce. A recent invention, however, promises to make air conditioners much more useful.

The CoolBot

The Coolbot is an electronic gadget (www.storeitcold.com) marketed since 2006 that enables air conditioners to operate well below their normal base temperature. For example, a basic air conditioner fitted with a CoolBot will easily keep a modest, well insulated storage room in the –1°C (30°F) range. Its makers claim that a CoolBot and air conditioner cost vastly less than the combined purchase, installation and maintenance cost of a conventional refrigeration system for a walk-in cooler.

Marcus Casson grows a variety of field and greenhouse vegetables near Tatamagouche, Nova Scotia. He installed a CoolBot in 2008 and claims it paid for itself after one season because so much less spoiled produce ended up on the compost pile.

"The insulation actually costs more than the CoolBot and air conditioner," says Casson. "I built a 10 x 13 ft storage room in an old barn and lined it with two layers of high density, blue foam insulation. Actually, two walls and a ceiling did not get finished, but even in August we had a constant temperature of 7°C [45°F]."

Casson figures he has spent about $2000 on his storage. The specs called for an 18,000-BTU (British Thermal Unit) air conditioner, but because the cost jumps dramatically for this size machine (more than $800), he skimped a little and opted for a 12,000-BTU unit costing $325 instead. The CoolBot cost U.S. $290. He thinks installing the same refrigeration capacity with conventional technology would have cost $5000.

One disadvantage of using air conditioners is the high air flow and dehydration effect. "The cooler tends to run dry," says Casson. "It's great for onions because they never pick up humidity, but some crops like beans and zucchini are very quick to shrink or dimple." Casson says it is essential to cover sensitive crops to avoid post-harvest losses.

He wonders, however, if having two 10,000-BTU units and a divider in the room would allow him to keep different storage temperatures and avoid mixing ethylene-sensitive crops with his tomatoes.

An added benefit of well insulated cool rooms is frost protection in winter. Casson points out that some modern air conditioners are designed to heat as well as cool and these may have an application for storage.

Other essential features are insulated doors, low heat lighting and plastic strip curtains for the doorways. The only other burning issue, he says, is whether his next CoolBot cooler should be built using straw bale construction.

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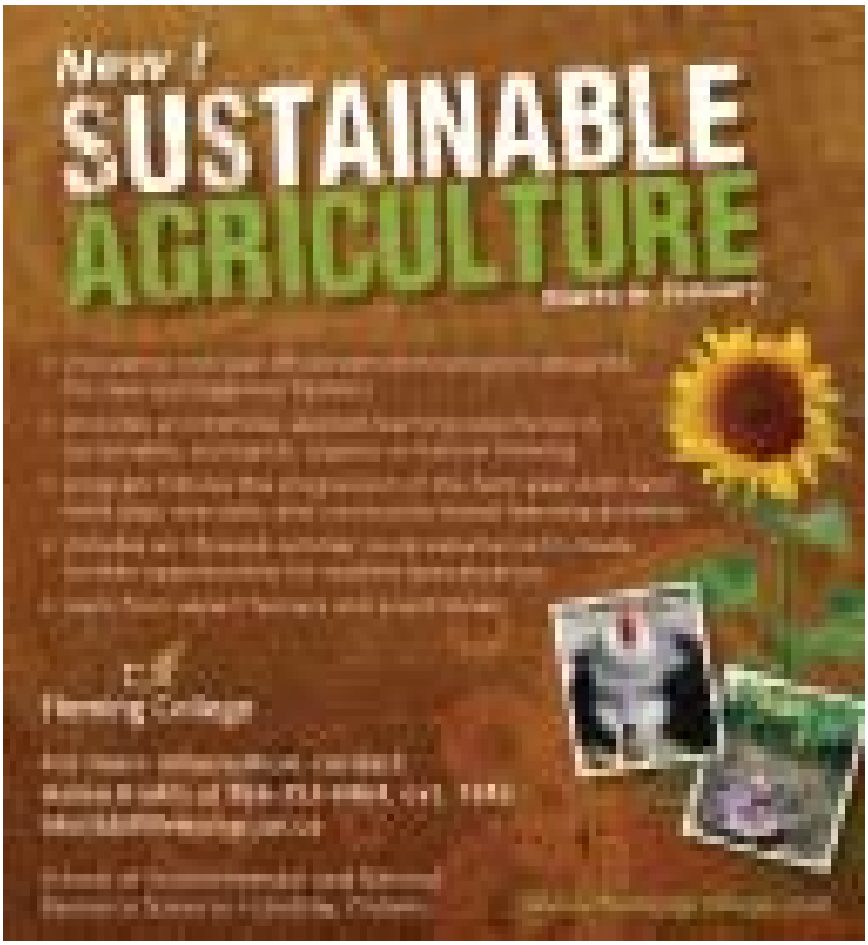

Resources

North Carolina Cooperative Extension Service publishes a variety of resources on cooling and post-harvest handling for different crops: www.ces.ncsu.edu/dept/hort/hil/post-index.html

The University of California-Davis website lists fact sheets for a broad range of produce: http://vric.ucdavis.edu/

Postharvest Handling of Fruits and Vegetables: www.attra.org/attra-pub/postharvest.html

Produce Handling for Direct Marketing, the Natural Resources, Agriculture and Engineering Service (NRAES), 1992, is a 26-page document for farmers selling at markets and roadside stands.

"Small Scale On-farm Cold Storages" provides many useful specifications for storage structures, refrigeration units, as well as detailed tables describing the storage needs of crops: www.agf.gov.bc.ca/resmgmt/publist/300series/306300-3.pdf