ACORN
Atlantic Canadian Organic Regional Network

Inexpensive Options for Cooling Produce

Prepared By ACORN's Transition Specialist: Rupert Jannasch

Some years ago, a Nova Scotia farmer caused a stir by insisting that organic produce had a shorter shelf life than conventional types. A spirited debate was resolved with agreement that keeping quality had as much to do with shoddy product handling after harvest as with 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 dry and overall cleanliness help to maintain quality, but by far the easiest way to protect your investment is to swiftly reduce the product's field temperature.

A rule of thumb says 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 that affect the afterlife of a vegetable or berry should be considered before the cooling process. Excessive irrigation and high plant densities in strawberries, for example, will hasten the onset of molds which cause fruit rot. High 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 are other pre-harvest factors affecting 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, during 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.

Dr. Robert Prange, a post-harvest handling expert with Agriculture and Agrifood Canada in Kentville, Nova Scotia, recalls 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."

Evaporative cooling

Another inexpensive cooling method for a packing house situation is evaporative cooling. Passive or forced air passing through a wetted material like burlap or excelsior 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.

ooling produce is an exercise
temperature management. The
rst step is removal of field heat
ıd the second is maintaining a
itable storage temperature.

eld heat removal will be fairly
ow in large, confined and
oorly ventilated spaces with a
eat deal of air space. Most
alk-in coolers, for example, are
ry inefficient at removing
eld heat. That is why large-
ale produce growers rely on
ydro-cooling, vacumn cooling
ıd ice to remove field heat.
efrigerated trucks are designed
maintain product temperature,
ot reduce it.

r. Robert Prange says
gardless of the scale of
erations "the first thing
owers should do is invest in a
od thermometer. It should be
ılibrated, especially if it is
ectronic, in ice water which is
2°F. This is a cheap investment
ıd growers can look around
nd poke into] their product and
t feedback all on their own."

Water or hydro-cooling

Water is an excellent cooling medium because it absorbs heat more efficiently than air. Some vegetables like 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 cool a crop like lettuce, keep it crisp and clean it in the bargain.

A water source that is naturally cool, like 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 it will ratchet up hydro costs.

A technique that works well with spinach is to wash it in cold water and stuff some gently in a clean pillowcase. Spin it in a Hoover spin dryer for a minute or so and out comes clean, dry spinach. All water sources should be tested regularly for contaminants.

Many of the techniques mentioned here are really pre-cooling techniques used prior to placing produce in a cool storage space. There are numerous websites (see below) that have tables describing the storage needs of different crops. The main storage requirements to check for are:

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

Storage temperatures for some crops may be overstated. For example, the optimum storage temperature for blueberries is often listed as 32 °F or just above freezing. This is fine for long-term storage, but has little relevance for someone planning to sell their berries at a farmer's market the next day. A Government of British Columbia document on small-scale cold storage (see below) 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.

But 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 the coolie is tired. Unless entry can be made with a hand truck or other wheeled device, basement storages should be avoided whenever possible.

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 fruit such as tomatoes, ethylene can cause changes in colour, flavour and firmness in a variety of produce. 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 suggests 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.

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.

Freezers, however, are generally well insulated. A new product manufactured by Johnson Controls is a thermostat control for a working freezer. This device, sold at Noble Grape stores, sets exact temperatures by using the existing compressor. Basically, it prevents the freezer from freezing. It sells for $89.99.

Another method is to convert a chest freezer into a refrigerator by replacing the temperature control with a rheostat (like a dimmer switch) - from a discarded refrigerator.

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 a small space full of produce cool than a large, half-empty space full of air.

A portable cooler designed by the USDA is described in Post-harvest 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 very modest cooling capacity since they mostly do not operate below 60° F. Their main disadvantage is causing desiccation or the drying out of produce. A recent invention, however, promises to make air conditioners much more useful.

The CoolBot

The CoolBot is an electronic gadget marketed since 2006 that allows air conditioners to operate well below their normal base temperature (www.storeitcold.com). For example, a basic air conditioner purchased at a box store fitted with a CoolBot will keep a modest, well insulated storage room in the 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 in the compost.

“The insulation actually cost 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.”

Casson figures he has spent about $2,000 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 US $290. He thinks installing the same refrigeration capacity with conventional technology would have cost $5,000.

One disadvantage of using air conditioners is the high airflow and dehydration effect. “The cooler tends to run dry,” says Casson. “Its 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 air conditioners nowadays are designed to heat as well as cool and these may have an application for storages.

Other essential features for a cool room, he says, are insulated doors, low heat lighting and plastic strip curtains for the doorways. He also wonders whether his next CoolBot cooler should be built with straw bale construction.

Additional Resources

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

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

Produce Handling for Direct Marketing, published by 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

Growing for Market (www.growingformarket.com). Website, newsletter and books cover many useful topics including produce cooling for direct marketers.