

Introduction

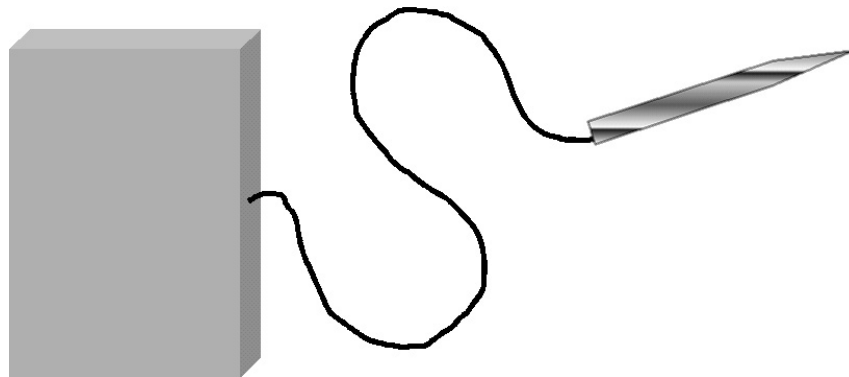
Measuring temperatures is important for understanding the handling conditions that fresh produce experiences. Simply feeling produce temperature is not adequate. Measuring temperature with a measuring device such as a probe thermometer is essential for properly understanding core produce temperature. However, thermometers only measure temperatures at a single point in time. To properly understand the whole handling chain a probe thermometer would have to be used right through the handling chain and all the results written down. Most people don't have the time or inclination to stand around in cool rooms and continuously measure fruit or vegetable temperatures. Temperature data loggers can be used for this task, enabling the whole handling chain to be monitored without someone having to be in place to keep a record of the temperatures.



What are temperature loggers?

Temperature data loggers are small, electronic devices that measure temperatures and keep a record of the results over time. They come in a range of shapes and sizes, but are usually small enough to fit within a box of fruit or vegetables.

To accurately measure produce temperature loggers should be fitted with external probes that can be inserted into the centre of produce. Probes are usually fitted to a cable which is attached to the logger.

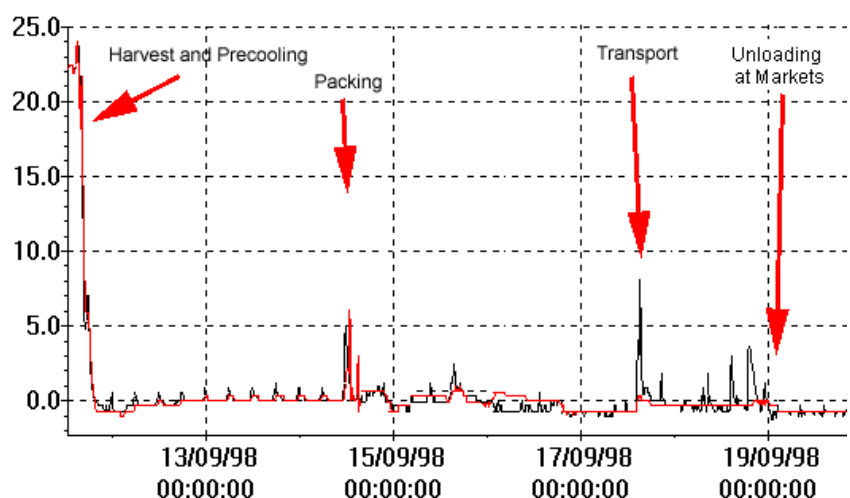


Temperature logger - Contains electronics, memory and battery. Usually in a plastic case.

Lead and temperature probe - The temperature is measured from the end of the probe.

What information can loggers provide?

Data loggers give a record of temperature over time. A typical setting is for the logger to record the temperature of the probe every 10 minutes. Results are most easily seen by presenting the data as a graph. When presented as a graph, the temperatures at any time during the logging can easily be read.



The Temperature Data Logging Process



Step 1: Starting the logger

Loggers are usually started by connecting to the computer. Various options are available when setting up the the logger, such as the time interval and total logging duration. A usual set up will have a logger taking a temperature recording once every 10 minutes. Depending on the logger type this may give a total logging time of 2 or more weeks.

Some loggers are started with special keys or magnets which means they can be started just before the loggers are used in the field.



Step 2: Using the logger to measure temperatures

Loggers can be used to measure temperatures anywhere along the handling chain. Use loggers to measure temperatures in the field, in field containers, in the cool room, in packed product, during transport, at the wholesale markets etc. It is a good idea to mark the boxes/containers that a logger is in so they can be easily located.

Produce temperature, rather than air temperature is the most useful recording. A good practice is to probe produce in the field and then log the temperature of that one item right through the handling chain.



Step 3: Getting the loggers back

To ensure loggers are returned from destination markets requires some planning and coordination. When consigning produce with a temperature recorder to a wholesaler or retailer, phone and fax them to let them know a logger is coming and needs to be retrieved. On the phone, organise with an individual to ensure the logger is retrieved. Sending a fax only may not be sufficient.

Enclosing a self addressed, prepaid postage bag along with the logger makes it quick and easy for people collecting the loggers to return the loggers to you.



Step 4: Viewing the information

Once the logger is returned, it must again be hooked up to the computer to view the results. The computer will retrieve the information off the logger and display the results as a graph. The graph will show all the temperature recordings taken and the times at which they occurred. This should be saved for future reference and can be printed. Record details and comments about the logging to enable interpretation of the data at a later date.

When the information has been retrieved and saved, the logger can be restarted and used again.

What are they used for?

One of the main uses of temperature loggers is for measuring produce temperatures throughout the marketing chain. However this is not their only use in horticulture. To get the most from a data logger it can be used for a number of purposes. Particularly for seasonal produce that is only harvested and transported for part of the year, loggers can be put to use for other purposes.

Other uses include

- They can be used to measure chill hours within an orchard
- To measure the microclimate of different properties or fields in relation to pests and disease
- As frost warning devices

Measure produce temperature

Temperature loggers can measure air temperature or produce temperature (some can do both). Measuring air temperature can be useful in getting an idea of how the produce has been handled, but it is an indirect measure of what we are trying to find out. By measuring produce temperature directly we can more closely examine how the handling procedures have impacted on the produce. Measuring air temperature can give misleading results. If produce is being moved from a cool store to a refrigerated truck, the air temperature recorded will quickly jump on the graph, although the actual produce temperature may not have changed much at all.

Recording the logger movements

When using a logger it is important to keep a written record of when where the logger is being used. This information can then be compared with the actual temperature results when the logger is downloaded, to determine the impact of each handling practice. Information to record includes each time the produce moves location, eg transport back to packing shed, into the cool room, packing etc. There is a form on the back page that can be copied and used to record temperature information.

Getting assistance with temperature monitoring

Temperature data logging is not restricted to those with computer access. Even those with computers may be too busy to deal with setting up loggers and then downloading and printing results. There are groups that can assist with temperature data logging in various ways. At each of the wholesale markets there are market based recording services that offer logger retrieval and downloading of the information from the loggers. Results can be faxed back to the grower as soon as they are downloaded.

Using an external group to retrieve and get the information means that the workload is reduced on the grower/packer. The logger is placed in with the produce and the retrieval service at the destination market notified that the logger is coming.

Important features

Some important features to consider when purchasing a logger for monitoring produce temperature are

- Does it have an external probe, this is required to measure produce core temperature?
- Is the computer software to run the logger compatible with your computer and easy to use?
- Is the logger robust enough to survive the handling conditions?
- Is the logger a suitable size for your needs?

Special functions

Each logger has its own range of features that can be beneficial for different circumstances. Some make use easier, others add extra functions and uses for the logger. These include:

- **Quick start mechanisms.** Some loggers use a special button, switch or magnet to start the logger on the spot rather than using a computer to start the logging process.
- **Alarms.** There are a range of alarms that can be set on some loggers. Upper limits (if temperature

gets too warm) and lower limits (if temperature gets too cold) can be set. If the set limits are exceeded small lights may flash, beeps may be sounded or external alarms triggered.

- **Multiple channel loggers.** Some loggers can record more than temperature from a single probe. Dual (2) channel logger combinations include probe and air temperature readings; humidity and temperature; and two probe temperature readings.
- **Software features.** There are numerous features of the software programs, which are constantly being upgraded. Useful features include: the ability to zoom in and see only specific sections of the graph; the ability to view data from multiple loggers on a single graph; basic statistics including maximum, minimum and average temperatures; more detailed statistics including time outside the alarm range; a setable delay before the alarm activates, ability to set multiple loggers with the same settings and so on.

Further considerations

Once you have a logger, you will want to get the best out of it. Placing a logger anywhere in the the load will give you good information. However, loggers can be used to answer specific questions.

How long does it take for all my produce to get cold in the cool room? Produce on the outside edge of a pallet or on top of a bin will cool much faster than in the middle of a stack. When cooling it is important that all produce is properly cooled. Measuring only the most exposed produce may give a misleading cooling rate for all the produce. If you are looking at cooling rates, it is valuable to measure produce in the centre of the stack as this will be the slowest to cool.

Is produce warming up during transport? While produce in the centre of a pallet is the slowest to cool down, it is also the slowest to warm up. If you are primarily interested in determining whether produce is warming up during transport, probe produce near the edge of the pallet. If any warming is occurring this produce will be the quickest to show results.

Are different techniques having an effect on produce temperature? There are systems that can be used to improve the cool chain. These include rapid cooling techniques like forced air cooling, produce covers like bin covers and pallet blankets for reducing heat inputs into produce. Temperature loggers can be used to verify whether these procedures are working and demonstrate where further improvements can be made. Comparison of temperature graphs from before and after systems are implemented will highlight any changes.

Wasting produce

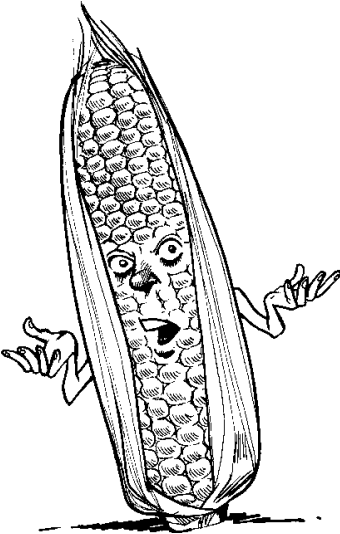
Naturally there is some concern from growers at wasting produce by probing a hole in it. However, the cost of wasting one piece of fruit or vegetable in a load is small compared with the potential large losses when the cool chain breaks down. Downgraded quality, rots and moulds, weight loss and shrivelling will all result in larger losses than a single item being unsaleable. If produce in a load is being probed multiple times (with loggers and probe thermometers) then the same item can be used each time, rather than probing a different item, to minimise the amount of produce being damaged.

Temperature loggers and QA

Temperature control should be an important part of any quality system for fresh produce. Temperature logging can be used to verify produce temperatures and identify where any problems exist.



Activity - How much memory do I need in my data logger?



Loggers have different capacities for the number of readings they can record. Bigger is better in terms of memory, but a logger with more memory will also cost more. Also, extremely detailed information is not always needed as taking readings every 30 seconds may not give any more usefull information than a reading every 10 minutes. This excercise can be used to determine what capacity logger will be necessary for your situation.

Step 1: Determine how often you will need to take a reading

The amount of time that is needed between each reading is dependent on how quickly temperatures are likely to change during the logging period and how detailed the final temperature information needs to be. The time between each reading is known as the logging interval. If measuring an action over a short period of time that requires detailed information (say evaluating a hydrocooler) then a short logging interval of 1 minute (or less) might be appropriate. If measuring field temperatures to evaluate daily weather patterns a logging interval of an hour may be sufficient.

When logging temperatures through a normal marketing chain, a logging interval of 10 minutes usually captures enough information.

Step 2: Determine how long you need to record for.

If your handling system from harvest to market is 4 days the logger must record for at least that long. It is a good idea to allow a margin for error because delays do occur in handling systems which can make the time from harvest to market longer than expected.

Step 3: Determine how many readings you need to take.

The table on the following page can be used to determine how large the capacity of the logger needs to be for a series of logging intervals and time periods. To work out the exact logger capacity required use the following calculation. Make sure that when purchasing a logger the capacity is at least as large as your calculated value.

Logger Capacity (Number of readings) =
$$\frac{\text{Total logging time (days)} \times 1440}{\text{Logging Interval (minutes)}}$$

=
$$\frac{\text{[]} \times 1440}{\text{[]}}$$

Your logger capacity should be more than this value = _____



Temperature Monitoring Data Sheet

Logger Number: _____ **Start Date:** _____ **Region** _____

Logging run description: _____

Activities Log - Enter the date, time and details for each time the logger is moved to a different location or when it enters a different phase of the handling chain (eg produce loaded in cool room, forced air cooling turned on, produce loaded on transport vehicle). Use the Notes section to record specific points eg package types.

No.	Date	Time	Action Details	Notes	Temp.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					