2.1 WEATHER MONITORING EQUIPMENT

Fact sheet objectives

- To describe weather monitoring equipment suitable for on-farm use.
- To provide information required to select appropriate monitoring equipment.
- To highlight sensor location and maintenance requirements.

Why monitor weather?

The most important weather variables that affect crop or pest and disease development, crop damage, irrigation requirements and spray application are; air temperature, soil temperature, humidity, rainfall, surface wetness, wind speed and direction, and solar radiation.

Weather recording options

All of the above variables can be recorded using manual (usually analogue) sensors – the most common currently being a maximum/minimum thermometer and a rain gauge.

Manual recording requires a regular time commitment that can be reduced by use of electronic data loggers. These can range from relatively low cost sensors for single variables, to phone-linked automatic weather stations fitted with 10 or more sensors.

There is a mass of electronic logging options available to growers with an equally wide range in prices. Ignoring cost factors for now, when comparing recording options consider the following:

Sensor Precision = the resolution to which the sensor can measure a variable (e.g. 0.1 versus 0.5°C temperature) – what do you require?

Sensor Accuracy = the closeness of a sensor reading to actual conditions – this will be no less than plus or minus the sensor precision – again what do you require?

Sensor Range – will the sensor record over the full range of expected conditions? If not does it matter (a frost is a frost)?

Sensor Reliability – is the sensor robust and suitable for use in the intended location? Many of the less expensive loggers are not suited to long term out door use. Expect, and be prepared to pay for, at least five years field use.

Logging capacity – how long can the logger run unattended? How often are you prepared/able to download it? Three months is a good minimum to aim for.

Programming – how is this done and how hard is it to do? Ideally you should be able to drive the logger without reading the manual.

Downloading – how is this done? Options in order of diminishing pain and increasing cost are; logger to computer, computer to logger, logger linked to computer by wire, logger accessible remotely by computer using a phone or radio link.

Two electronic weather stations, linked to telephone modems and fitted with a range of sensors.

Regardless of the method used to record weather information, it will only be of use if the data are **reliable** and can be readily **accessed** and **interpreted**. Data reliability is partly a function of the logger characteristics, but whether or not the information represents the conditions experienced is also driven by sensor placement and calibration and maintenance.

A multi channel programmable data logger (Campbells CR10).

Data loggers

There is a large range of commercially available data loggers that can be divided into the following two sets of categories *(note: no commercial endorsement is implied in the product examples cited).*

Integrating loggers

In typical use the sensors on an integrating logger are accessed each minute and the minute-by-minute data are stored in temporary memory and used to produce average, maximum, minimum and/or totals for each hour and/or day.

These represent the most sophisticated type of data logger in common use and can usually accept a large range of meteorological sensors and can be programmed to record data in different ways.

They are usually very reliable, but are expensive to purchase and are relatively complex to programme and operate.

These sorts of logger can usually be accessed by way of telephone or radio modems to enable data downloads to a remote personal computer.

Examples include Campbell Scientific CR510 and CR10X which are used on virtually all HortResearch weather stations

A dual channel low cost sampling data logger (Tiny Tag).

Sampling loggers

This type of logger has less memory and programming capability than integrating loggers, so simply records sensor values at user specified intervals. In typical field use for weather monitoring sensor readings are made at approximately 10-minute intervals. Almost all of the lower cost loggers operate in this way.


The low cost Ibutton Thermochron temperature logger

Multiple channel loggers

Many purpose built weather stations are effectively loggers that can record more than one meteorological variable and come equipped with a standard set of sensors.

Examples of off the shelf weather stations include the Davis weather station, which is a mid-range product for home, school and small business use. Another is the GroWeather station aimed at agricultural and horticultural use.

Single channel loggers

Loggers of this type are most commonly used to make short term or point measurements that can then be compared with data from a weather station located elsewhere. However, the combination of temperature, surface wetness and possibly other variables recorded by single channel loggers can provide an effective low cost weather station option.

Examples of single channel loggers include Tiny Tags and IButtons.

Siting a weather station

Plastic stacked plate sensor screen sold for use with Tiny Tag loggers.

The wooden Stevensons screen (small version shown) is the world standard screen for meteorological observations

Tipping bucket rain gauge with wide collection funnel used for 0.1mm tipping increments. The tipping mechanism is shown below.

Shelter and aspect create varying microclimates within a property. Likewise, the nature, stage of development and management of the crop canopy will also change the microclimate it experiences.

Scale is a major consideration in siting a weather station – generally it is desirable to obtain weather information that represents the property as a whole, rather than be specific to individual blocks.

For this reason we recommend location of instruments on level ground in a grassed area, away from the immediate vicinity of buildings. This avoids sensor damage during crop management operations and provides standardised data that can then be related to different crop canopies.

If you prefer to site the weather station in a block or paddock, remember that the temperature, surface wetness and other data in particular may not be representative of other blocks and will have little historic value.

If instruments are read manually, or if you download data directly to a laptop computer, then convenience of access is a consideration that often outweighs ideal location of sensors.

Sensor types and deployment

Temperature sensors must be shielded from the sun by a suitable screen of known performance. The standard is the wooden Stevenson screen, suitable for manual thermometers and for electronic sensors. There are two sizes. There are also smaller stacked plate screens, which allow a weather station to have a smaller footprint. Both types of screen can overheat on calm days, and read low on clear nights, but overall these extremes average out.

Relative Humidity (RH) is generally measured with an electronic capacitive sensor, which again must be suitable housed out of direct sun and protected from rain. Humidity sensors often include a temperature output. Almost no electronic humidity sensors are accurate at humidities above 95% and as such do not necessarily provide a reliable indication of the presence of free moisture on plant surfaces. It is also possible to calculate RH from wet and dry bulb air temperatures. This method, although cheaper, relies very much on the dedication of the owner to maintain the wet bulb wick and water reservoir. **Rainfall** is traditionally measured with a cylindrical gauge of standard diameter, which collects the rain catch for subsequent reading in a glass or plastic measuring cylinder.

Most electronic rain gauges use a tipping bucket that 'seesaws' on collecting a fixed rainfall amount, usually 0.1mm, 0.2mm or 0.5mm. The rain gauge should be sited away from trees and buildings – the rule of thumb is at a distance twice the height of the tree or building.

An alternative type of rain gauge counts the numbers of drips produced from a constant funnel diameter. Whatever the system, it is essential to ensure that the rain gauge funnel does not become blocked by insects or dirt.

***Surface wetness* duration** is important for estimating disease risk (Fact sheet 2.2). Most data logger manufacturers offer wetness sensors, usually the flat plate artificial leaf type, although some manufacturers offer a cylindrical sensor. Flat plate wetness sensors should be inclined at 10° to the horizontal facing north.

Wind speed and direction provide important information relevant to spray application. Wind speed is measured with an anemometer; a spinning set of cups produces electrical pulses or a varying voltage. Wind direction is measured with a wind vane. There are a number of standard heights for setting up wind sensors, aimed at making the measurements above the **boundary layer** of air near the ground. Two standards are at 6m and 10m.

Light has a large influence on plant growth and development, and can be recorded as solar radiation or photosynthetically active radiation (Fact sheet 2.6). Current sensors use a silicon photovoltaic cell.

Cup anemometer used to measure wind run. Shown on a met mast below with wind direction and solar radiation sensors.

Summary Information

- Weather information provides input to many aspects of farm or orchard management
- Siting a weather station requires care
- There are several levels of technology available, from manual reading to telephone access data loggers
- Sensors require proper housing and deployment and appropriate calibration and maintenance

Useful Websites

Campbell Scientific:	www.campbellsci.com
Davis:	www.davisnet.com/home_static.asp
Gemini (Tiny Tag):	www.geminidataloggers.com
Ibuttons	www.hortplus.com
Glossary of terms	http://k12.ocs.ou.edu/teachers/glossary/

A MAF Sustainable Farming Fund Project:

Sustainable Farming Fund
www.maf.govt.nz/sff

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