3.4 HUMIDITY MEASUREMENT

Fact Sheet Objectives

- Discuss atmospheric water vapour
- Describe relative humidity measurement
- Illustrate use of humidity information in disease models

Water Vapour in the Air

Air can hold a limited amount of water vapour, depending on the temperature. The maximum amount of water vapour at a given temperature is known as the **saturation** value.

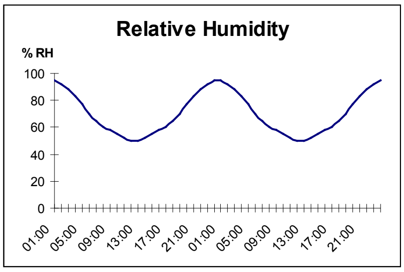


Figure 1. Typical variations in relative humidity over a 24 hour period.

Absolute humidity is a measure of how much water (grams) is contained in the air (per cubic metre). Unfortunately the less useful **relative humidity (RH)** is usually calculated and quoted. Relative humidity is the percentage of water vapour in air to its saturation value. Atmospheric relative humidity varies considerably over a 24 hour period as the temperature changes (Figure 1). Our subjective sense of 'humidity' is a poor indicator of the true relative humidity. This is because RH does not say anything about the amount of water in the air, unless the temperature is given (see Table 1 on the next page).

Vapour pressure deficit

Are these high humidity conditions?

A better way of describing moisture content of air is in terms of Vapour Pressure Deficit (VPD). VPD is a good indicator of plant transpiration potential as it indicates the 'drying effect' of the air. The vapour pressure (VP) is the pressure caused by a gas or a vapour. All gases in the air together make up the air pressure. Vapour pressure of water normally ranges from 10 to 50 mbar (millibar) or in other units, from 1 to 5 kPa (kilo-Pascal). At each temperature there is a maximum vapour pressure of water and if more water was added water would condense. Vapour Pressure Deficit (VPD) is the difference between the actual and the maximum vapour pressure. For water vapour, VPD is normally in the range 0.1 kPa (very humid) to 3 kPa (very dry air), or 1 to 30 mbar. Note that a low VPD means a high air humidity, and vice-versa. The higher the VPD the stronger the drying effect, so the stronger the driving force on transpiration.

Dew point

Dew Formation

Dew point is the name given to the temperature at which air becomes saturated. At temperatures above the dew point all the moisture can be accommodated as water vapour, which is invisible. As the temperature falls below the dew point, more often at night, the air becomes saturated and water droplets appear as dew on surfaces, and suspended in the air as fog.

Dew point is a good indicator of the moisture content of the air, and in warm humid weather it is also an indicator of human discomfort. A dew point of 24ºC is generally regarded as extremely humid or 'sticky'.

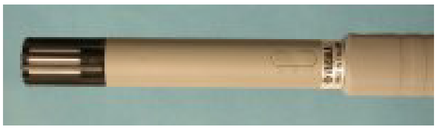
Table 1. Comparison of relative humidity (RH), absolute humidity (abs.) and Vapour Pressure Deficit (VPD).

	at 10 °C		at 15 °C		at 20 °C		at 25 °C		at 30 °C	
RH	abs.	VPD	abs.	VPD	abs.	VPD	abs.	VPD	abs.	VPD
%	g/m^3	kPa	g/m^3	kPa	g/m^3	kPa	g/m^3	kPa	g/m^3	kPa
100	9.42	0	12.86	0	17.33	0	23.09	0	30.43	0
95	8.94	0.06	12.21	0.09	16.47	0.12	21.94	0.16	28.91	0.21
90	8.47	0.12	11.57	0.17	15.6	0.23	20.79	0.32	27.39	0.42
85	8	0.18	10.93	0.26	14.73	0.35	19.63	0.48	25.87	0.64
80	7.53	0.25	10.28	0.34	13.87	0.47	18.84	0.63	24.34	0.85
75	7.06	0.31	9.64	0.43	13	0.59	17.32	0.79	22.82	1.06
70	6.59	0.37	9	0.51	12.13	0.7	16.17	0.95	21.3	1.27
60	5.65	0.49	7.71	0.68	10.4	0.94	13.86	1.27	18.26	1.7
50	4.71	0.61	6.43	0.85	8.67	1.17	11.55	1.59	15.22	2.12
40	3.77	0.74	5.14	1.02	6.93	1.41	9.24	1.9	12.17	2.55
30	2.82	0.86	3.86	1.2	5.2	1.64	6.93	2.22	9.13	2.97

Table 1 shows the conversion from one unit into other units, at various prevailing temperatures. For instance at 20 °C, 80% RH equals 13.87 g/m^3 absolute humidity, and 0.47 kPa VPD.

Humidity Measurement

A common type of humidity sensor is the capacitive sensor or 'humicap'. The capacitance of a solid state sensing element changes as water vapour diffuses into the dielectric between deposited metal strips. Humicap sensors are reasonably accurate, but do require recalibration every couple of years.



A modern humicap, electronic humidity sensor.

An older method is to calculate relative humidity from wet and dry bulb temperature sensors. When the humidity is 100% or when the wicking is dry, the wet bulb temperature equals the dry bulb temperature. Otherwise the wet bulb temperature is a few degrees below the dry bulb temperature.

The more sophisticated data loggers can make the necessary calculations and output a relative humidity reading. The temperature sensors must be closely matched. This method is cheap to set up, but relies heavily on the dedication of the operator to maintain the wet bulb wick and water supply.

Housing

Field sensors must be properly housed to avoid rain and direct sunlight. Ideally a wooden louvred screen (Stevenson screen) should be used, or alternatively a stacked plate screen specifically designed for the particular sensor.

Use in Disease Models

Harvested Onions field drying – low humidity is beneficial

Surface wetness sensors (Fact sheet 2.3) are more commonly used than humidity sensors in pipfruit and winegrape disease models. This is partly because reliable humidity sensors are more expensive than wetness sensors and because there is a lack of reliable hourly humidity data in historic meteorological databases from which to build disease prediction models.

Most diseases are more limited by a lack of free moisture than by a lack of suitable humidity conditions. Most commercial humidity sensors are reasonably accurate up to approximately 95% RH, but are inaccurate in the range 95-100% RH. Free moisture can be expected to be present on plant surfaces when relative humidity exceeds approximately 98%. At present humidity data are not used in any of the NZ apple or grape disease prediction models, but it is used in some vegetable disease models.

Figure 2 shows the output of a disease model developed for calculating onion downy mildew infection periods as part of the Metwatch software package.

Onion downy mildew prediction using humidity data.

The central red trace represents humidity. High humidity in the early hours of the morning has provided conditions for the fungus to produce spores (red bar, upper trace). Another set of conditions then allows infection (blue bar) later in the morning and in the evening of the same day.

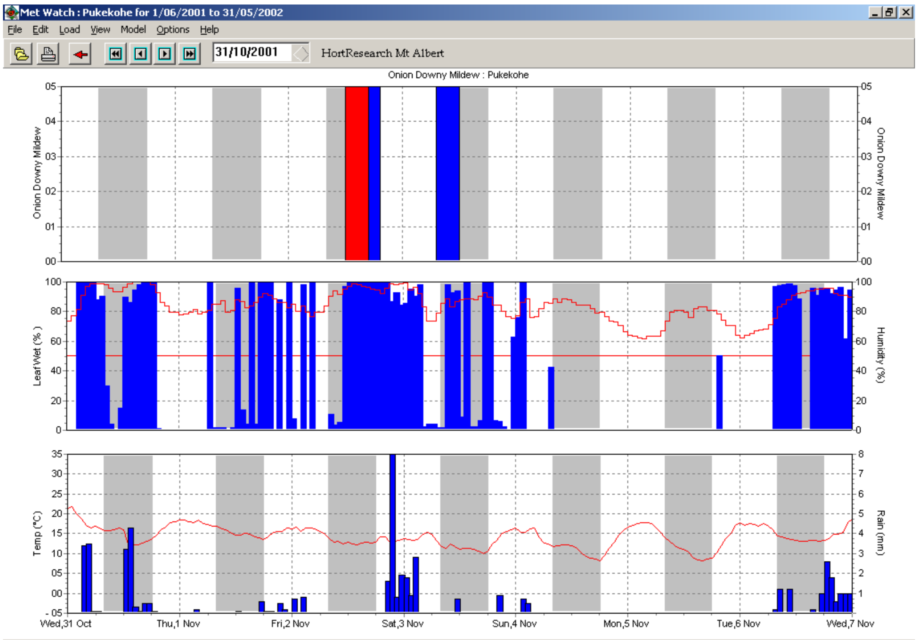


Figure 2. MetWatch Onion Downy Mildew disease model output illustrating calculated infection periods.

Summary

- Relative humidity measurements provide a temperature dependent indication of the water vapour content of the air.
- High relative humidity without free surface moisture may be required by some pathogens, but the difficulty of obtaining reliable humidity data means it has not been widely used for disease prediction.
- Likewise, while humidity will have an affect on potential crop evapo-transpiration (ET), not all ET relies on humidity measurements.

Further Information

A good HortNET guide to humidity, terms, measurement and effects on plants
http://www.hortnet.co.nz/publications/science/n/neder/humid01.htm