

## 3.2 Microclimate

### Fact sheet objectives

- To introduce the scope and main aspects of the *microclimate*.
- To list some ways of obtaining a favourable microclimate through the way an orchard is designed.
- To outline key aspects of the microclimate environment that control plant response.

#### Climatic scales

Scale	Time Dimensions
Microclimate	1 sec to 1 hour
Mesoclimate	1 hour to $\frac{1}{2}$ day
Macroclimate	$\frac{1}{2}$ day to 1 week
Global climate	1 week and longer

#### Scale name

#### Horizontal dimensions

Microclimate	1 mm to 1 km
Mesoclimate	1 km to 100 km
Macroclimate	100 to 10,000 km
Global climate	10,000 km to global

#### Scale name

#### Vertical dimensions

Microclimate	1 mm to 10 m
Mesoclimate	10 m to 1 km
Macroclimate	1 km to 20 km
Global climate	20 km to 100 km

#### Microclimate scale

Where does the microclimate start and end? Usually we associate microclimate with the area inside the boundary of an orchard or crop. It can also be defined as the climate of small areas that results from the way the geometry or physical properties of those areas modify the general climate.

The microclimate of your property (wind speeds, air temperature, rainfall) is usually different to the conditions measured at your nearest standard climate observing station, even if that station is quite close. This is because the weather in your property is influenced to some extent by physical aspects such as crop layout, soil type, shelter material, and so on.

The microclimate can also be thought of in the dimension of time - a sequence of atmospheric changes that occur within a small region.

Some typically used categories or scales of climate can each be viewed in three dimensions - time, horizontal distance, and vertical height above the ground. A working definition of these climate scales, by the World Meteorological Organization, is shown in the adjacent table.

In practice there is some overlap between the different climate scales, and so the categories cannot be rigidly defined. Perhaps a useful general definition of the microclimate, is that of the climate within the crop canopy and soil root zone that can be influenced by day to day management practices.

#### Orchard design influences on microclimate

The way a site is designed and laid out, its position in relation to nearby hills or water bodies, and the soil type under the crop, are all major influences on the microclimate.

*Slope* - ensures good water drainage, but steeper slopes can lead to more rapid nutrient leaching, and soil erosion during heavy rain. Slope helps improve cold air drainage, with the result that frost may be less frequent on sloping land than on the low-lying land below it. The use of sloping land can improve the solar angle, allowing sunlight to penetrate the crop canopy more effectively.

**Aspect** - North facing slopes (in the Southern Hemisphere) receive higher levels of radiation, which improves photosynthesis and increases the transpiration rates of well watered crops.

**Vegetation type and management** - It can't always be done, but if rows are planted north-south there is more chance that the sunlight can penetrate to ground level, and that shading between adjacent rows can be reduced. Shading can be helpful at times, for example to prevent sunburn, and at other times strategic pruning or topping can reduce shading to maximise irradiance.

**Wind effects** - Wind channelling and turbulence are real problems near large hills and in exposed areas. For example, strong winds during flowering not only damage the flowers but also make it more difficult for bees to successfully pollinate the crop. Shelterbelts are most effective when they are planted across the dominant wind directions, which may mean planting in more than one direction. Shelter should not be impermeable, as this can increase local turbulence, and also put the shelterbelt at risk in very high winds. As a general rule, about 40% porosity is recommended - that is about 40% of the air striking the shelter should be allowed to pass through.

**Soil type** - Water balance, nutrient availability, and aeration of the soil are all affected by soil type. Light soils typically drain more rapidly (provided there is somewhere for the water to go) than heavy soils, but require more frequent irrigation in dry seasons.

## Plant responses to microclimate

The best site microclimate is one that provides the most favourable environment for the desired plant response, that is, the response that maximises crop health and profitability. Key plant responses to microclimate can be managed in the following contexts:

**Radiation budget** - Radiation is the main source of energy for evapotranspiration. Plants need to transpire large quantities of water to produce harvestable product. For example, it is estimated that 1000 kg of transpired water is required to produce 1 kg of wheat. Plant density, architecture (the form and structure of the branches and leaves), and row alignment all affect the receipt and penetration of radiation.

**Soil moisture budget** - Plants photosynthesise best when both water and oxygen in the soil are non-restricting i.e. there is not too much or too little water, and air is available to the roots for as much of the time as possible. Mulching of the soil can be used to conserve moisture. Shelter generally decreases loss of moisture through evapotranspiration, mainly as a result of reduced wind speed and radiation.

**Chemical damage** - The danger of chemical damage, for example from spray drift, may to some extent be affected by microclimate. Some chemicals may have more impact on crops when plant surfaces are dry. Consult your advisor.

**Temperature of air and soil** - The ambient (within site) temperature range in most of New Zealand's cultivated regions is suitable for a range of crops. All crops have a temperature range



The microclimate is the environment within and close to the crop canopy and can be modified by crop training, covers, mulches etc.

Good site layout can have a positive influence on the microclimate.



(Photograph by Alistair McKerchar)

Row spacing and alignment influences how much solar radiation and direct sunshine reach the lower canopy. A shelterbelt across the end of the rows helps to reduce wind speed in the orchard, and help reduce spray drift.

in which they grow best, called the range of adaptation. Loss of production or damage to plants occurs when air temperatures fall outside their range of adaptation. Tolerance of high temperatures decreases when plants are under stress from low soil moisture levels. Soil moisture can be an important source of heat on cold nights to reduce frost risk - wetter soils have more latent heat than dry soils. Soil mulches can be used to enhance soil warming, or prevent excessive cooling, depending on the type of mulch used. Frost protection measures involve managing the heat that you have available in the field, or introducing new sources of heat.

**Pests and diseases** - The survival of pests and plants diseases is affected significantly by microclimate conditions. There may be ways you can manage and manipulate the microclimate to provide less favourable conditions for pest and disease incursions. Consult your advisor.

## Summary Information

- Microclimate can be defined as the climate of small areas where the geometry or physical properties of those areas has modified the general climate.
- Microclimate can be controlled to some extent by site design and crop management.
- Plant responses are highly sensitive to microclimate.

### Useful Websites

Microclimate management:

[www.biodynamic.org.nz/resrepch4.html](http://www.biodynamic.org.nz/resrepch4.html)

Microclimate management and frost protection:

[www.microclimate.co.nz/service](http://www.microclimate.co.nz/service)

A MAF Sustainable Farming Fund Project:



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