Microclimate

Fact Sheet Objectives

- Introduce the scope and main features of the *microclimate*
- List ways of modifying microclimate through orchard design
- Outline key aspects of microclimate that control plant response

Climatic scales defined by time and distance

Scale	Time Dimensions
Microclimate	1 sec to 1 hour
Mesoclimate	1 hour to ½ day
Macroclimate	½ day to 1 week
Global climate	1 week & longer

Scale	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	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

Figure 1. Climatic scales

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 where the general climate is modified, mainly because of the physical terrain.

Some typically used categories or scales of climate can each be viewed in three dimensions; time, horizontal distance, and vertical height above the ground. Working definitions of these climate scales, by the World Meteorological Organization, are shown in Figure 1.

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

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

Influences on microclimate

The way an orchard is designed, its position in relation to nearby hills or water bodies and the soil type, are all major influences on the orchard microclimate.

Slope

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, resulting in less frequent frosts on sloping land than on low-lying land below it.

Solar angle

The further south the property is, the lower the solar angle and the lower the overall radiation levels (although cloudiness is also a factor). 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 or sunlight, which improve photosynthesis and increase the transpiration rates of well-watered crops.

Crop layout and management

Planting rows north-south increases sunlight penetration to ground level and reduces shading between adjacent rows. Management tools such as strategic pruning or topping can also reduce shading to maximise irradiance. However shading at times can be helpful, for example to prevent sunburn, so needs to be considered and managed.

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

Wind effects

Wind channelling and turbulence are real problems near large hills and valleys in exposed areas. For example, strong winds during flowering not only damage the flowers but also make it more difficult for bees to pollinate the crop successfully. 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. It is extremely important that you find out the limitations and potential of your soil so you can effectively manage it.

Plant responses to microclimate

The best orchard microclimate is one that maximises orchard health and profitability. Several key aspects of the microclimate control plant response.

Radiation

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.

Row spacing and alignment influence 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 reduce spray drift (photograph by Alistair McKerchar, NIWA).

Soil moisture

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.

Temperature of air and soil

The ambient (within-orchard) temperature range in most of New Zealand's cultivated regions is suitable for a range of crops. All crops have a temperature range in which they grow best. Loss of production or damage to plants occurs when air temperatures fall outside their range of adaptation. Tolerance to 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 orchard, or introducing new sources of heat.

Agrichemical damage

The risk of agrichemical damage, for example from spray drift, may to some extent be affected by microclimate. While conditions may be suitable for spraying in one block, they may not be in another. Continue to check climate conditions as you move through the orchard.

Pests and diseases

The survival of pests, and plant diseases, are affected significantly by microclimate conditions. There are ways you can manage and manipulate the microclimate to provide less favourable conditions for pest and disease incursions. Consult your orchard advisor.

Summary

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

Further information

Microclimate management: www.biodynamic.org.nz/resrepch4.html

Hawke's Bay Regional Council: www.hbrc.govt.nz

Shelter belt design and understanding soil water see; Read about it - Environment Topics

Heretaunga and Ruataniwha Plains Soil Maps, see: What We Do - Land

Soil classification maps: NZ Land Resource Inventory and Land Use Capability, Landcare Research:

www.landcareresearch.co.nz/services/service_details.asp?Service_Tool_ID=97

Crop IR Log: an irrigation scheduling tool for vineyard owners and orchardists: www.cropirlog.co.nz

Best management guidelines for sustainable irrigated agriculture: www.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/irrigation/irrigation-best-management/httoc.htm

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