



Winter chilling recorded in Western Australia

By Kevin Lacey and Michaela Antoine, Technical Officers, South Perth

Introduction

Deciduous fruit trees need a certain amount of cold (chill) during winter in order to break dormancy and start flowering and growing in spring. If trees get insufficient winter chill they may experience delayed and uneven flower and leaf bud development. This in turn can cause a reduced crop, smaller fruit size, uneven size distribution, a long harvest period, poor fruit quality and the development of vigorous shoots.

Western Australia produces deciduous fruit crops in a range of climates from temperate to subtropical. The temperate fruit-growing region of the South-West provides sufficient chill for a range of medium and high chill varieties. The more recent introduction of low and very low chill varieties has extended production into warmer areas such as the Swan Coastal Plain and even to subtropical Carnarvon.

The West Australian Department of Agriculture and Food began recording the amount of winter chill received by the main deciduous fruit growing areas of the South-West in 1989. This study was later extended to include warmer potential fruit growing areas such as the Swan Coastal Plain and Carnarvon. Data was recorded until 1996 to incorporate seasonal variation.

To allow for comparison between years and sites, chill units were logged over a set period each winter. Sites with short winter seasons had appropriately shortened logging periods compared to sites with long, cold winters.

The chill information recorded can be used by growers as a tool for selecting varieties and making management decisions to overcome any lack of chill in their orchards.

Chill models

Two different models were used to calculate the amount of accumulated chill:

The traditional model records chill in **Hours Below 7.2°C**.

The Utah model records chill in **Richardson Units**. The Utah Model (Richardson Units) recognises the relative

contribution that different temperatures have on chill. These relative values are shown below.

Calculating Richardson Units using the Utah Model

Temperature °C	Richardson Chill units contributed
<1.4	0
1.4 - 2.4	0.5
2.5 - 9.1	1
9.2 - 12.4	0.5
12.5 - 15.9	0
16 - 18	-0.5
>18	-1

As each model calculates chill differently, the two models recorded different amounts of chill for each site.

Chill regions

Particular models were found to be more suitable in some areas than others. Three distinct chill regions were identified. These regions are shown on the following map (see figure 1).

Coastal and Sub-tropical

The Hours Below 7.2°C model is the most suitable for these regions (Swan Coastal Plain to Carnarvon). This is because Richardson Units generated by the Utah model are often negative due to daytime temperatures exceeding the 16°C threshold where chill accumulation is negative.

Middle and Upper South West

Both chill models are suitable for the South West region from Perth Hills to Balingup. Differences between the two models are not as great in this region (see figure 2).

Lower South West

The Utah model (which generates Richardson Units) was the most suitable for the lower South West region (Manjimup and Pemberton). This was because cooler daytime temperatures and longer periods of cloud cover during the day kept temperatures in the range where positive chill accumulation occurred for longer.

Important Disclaimer

The Chief Executive Officer of the Department of Agriculture and Food and the State of Western Australia accept no liability whatsoever by reason of negligence or otherwise arising from the use or release of this information or any part of it.

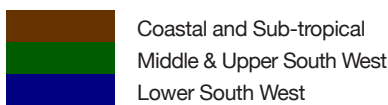


Figure 1. Three main chill regions identified within the study area.

This resulted in Richardson Units being considerably higher than Hours Below 7.2°C. This may explain why higher chill varieties perform well in the lower South West.

Variation in chill accumulation

One of the most noticeable things observed during the study was the amount of variation in chill that occurred. Chill recorded in any given year varied between regions, between different areas within a region and even between different sites within the same orchard. Much of this variation can be explained by differences

in factors such as slope, aspect and altitude. This largely explains why the same variety can flower at different times in different regions, areas, and even at different sites within the same orchard. There was also considerable variation between the amounts of chill recorded in different years, affecting a variety's performance from year to year (see Figure 2 and Table 1 for regional and area differences)

How can these results help you?

Growers can use these results as a guide to the amount of chill they could expect to accumulate in their orchard if it is within the area where the study was conducted. This in turn will help in choosing varieties with chill requirements suited to the area. Although these figures are useful they should only ever be used as a guide. The event of climate change in future years, will impact on the usefulness of this data.

Chill accumulation and variety selection

It is important to take variation in chill accumulation into account when selecting varieties for your orchard. Varieties should not be selected with a chilling requirement higher than what you would expect to get in a poor chill year because they are unlikely to perform to their potential consistently. Fruit breeders and nurserymen should be able to provide information on the chilling requirements of their varieties. Use information from other growers and research organisations on variety performance in your area if available. Where experience on a particular variety for a particular area may be lacking, a small trial planting on your own property before investing in large plantings would be very beneficial.

Recording your own chill

It is clear from the amount of variation recorded in this study that chill accumulation is highly site specific, and therefore all growers would benefit from using temperature loggers to record chill in their own orchard. Recording your own chilling will assist in:

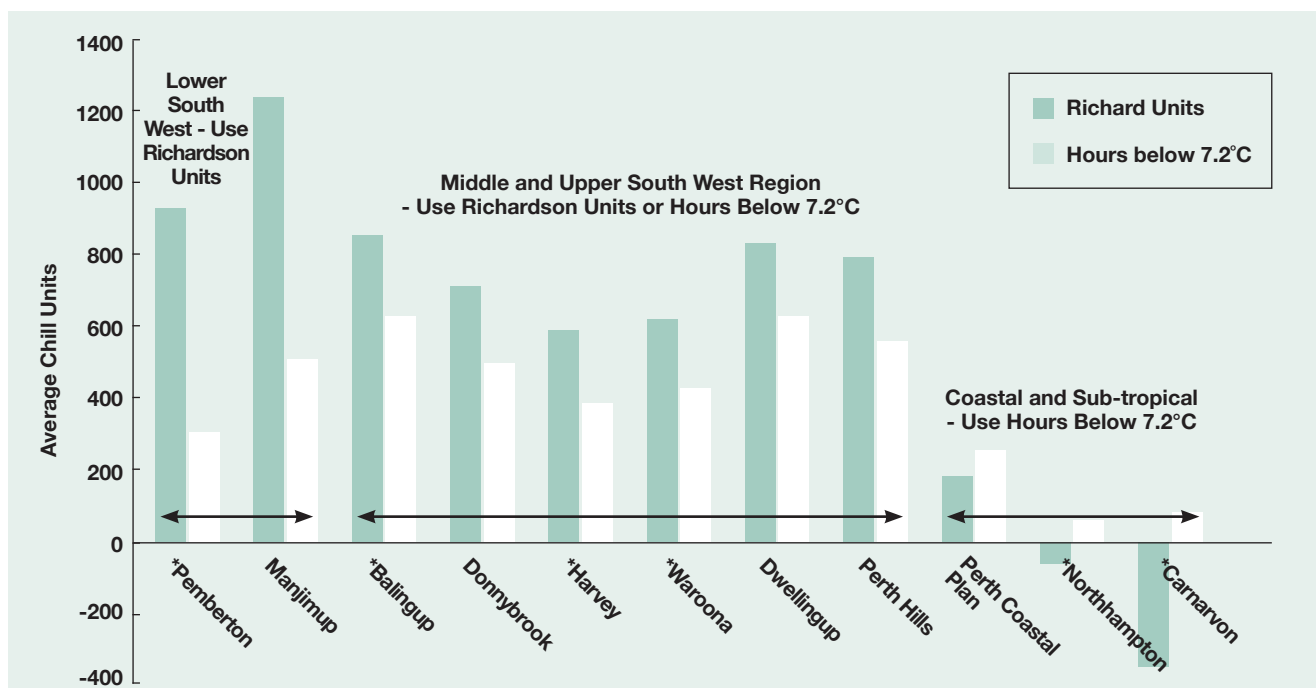


Figure 2. Average chill levels recorded for deciduous fruit growing districts in Western Australia using two models: Richardson Units and

Table 1. Average chill accumulation for each model and for each area (all sites and years), including the average for the highest and lowest site in the area where available.

Region	Area	Average Richardson Units			Average Hours Below 7.2°C		
		All Sites	Highest Site	Lowest Site	All Sites	Highest Site	Lowest Site
Coastal and Sub Tropical	Carnarvon*	-330.4	NA	NA	82.2	NA	NA
	Northampton*	-77.6	NA	NA	74.8	NA	NA
	Perth Coastal Plain	168.6	202.0	109.8	306.9	346.7	287.8
Middle and Upper South West	Perth Hills	780.6	940.1	650.6	521.6	677.9	442.0
	Dwellingup	831.3	886.8	771.8	649.8	661.4	638.3
	Waroona*	624.1	NA	NA	443.0	NA	NA
	Harvey*	576.5	NA	NA	388.4	NA	NA
	Donnybrook	699.3	859.2	563.9	483.4	585.5	420.3
	Balingup*	875.9	NA	NA	638.2	NA	NA
Lower South West	Pemberton*	919.7	NA	NA	279.0	NA	NA
	Manjimup	1227.3	1413.6	1080.2	504.3	650.4	380.5

*= One logger site only in this area, no highest or lowest site averages available.

- selecting varieties to match the chill received on your orchard site,
- determining when and if to apply rest breaking chemicals,
- determining if cultural management practices to reduce chill requirement are appropriate,
- forecasting crop performance, and
- interpreting year to year differences in variety performance

Temperature loggers are readily available and easy to use, and will download directly onto your home computer.

Further reading/websites

Allan, P. (2004). Winter chilling in areas with mild winters: its measurement and supplementation. *Acta Horticulture*. No. 662, pp. 47-52

Petri, J. L., Leite, G. B. (2004). Consequences of insufficient winter chilling on apple tree bud-break. *Acta Horticulture*. No. 662, pp. 53-60

Ashcroft G.L, Richardson E.A. and Seeley S.D. (1977). A statistical method of determining chill unit and growing degree hour requirements for deciduous fruit trees. *HortScience*. 12(4): 347-348.

Byrne D.H. and Bacon T. (Texas A&M University) "Chilling accumulation: its importance and estimation" <http://aggie-horticulture.tamu.edu/stonefruit/chillacc.htm>

New Mexico State University "Chill Unit Calculator Java version." <http://weather.nmsu.edu/nmcrops/Trees/apples/chilldly.htm>

Department of Primary Industries, State of Victoria, Agriculture Notes, AG 1094, ISSN 1329-8062, "Chill Units of Stone Fruit" <http://www.dpi.vic.gov.au/dpi/nreninf.nsf/LinkView/>

Alabama cooperative extension system, Fruit Culture in Alabama, "Winter Chilling Requirements" ANR-53-D

www.aces.edu/pubs/docs/A/ANR-0053-D/

