

## Introduction

The growth and development of horticultural crops such as apples and kiwifruit are strongly influenced by weather, including during the winter. While the winter may look like a time of inactivity many things are actually going on with the trees and vines, particularly with regards the development of flowers for the coming season. The coldness of the winter has a very strong influence in most horticultural crops on both the quantity and quality of flowers, as well as the timing of flowering.

Winter chilling is the term used to refer to how effective the cold of winter has been. For instance a year of high winter chilling will generally mean more kiwifruit flowers, an earlier flowering period once Spring temperatures arrive, and often a more compacted flowering period. A number of methods have been developed for measuring the effectiveness of winter chilling. The “chill units” described by each of these methods tries to account in various ways for the way a plant is influenced by winter temperatures.

## Chill Hours

One of the most common methods for calculating chill units is “Chill Hours”. A base temperature is chosen, say 7°C. If the temperature is above this base then it is too warm for the plant to accumulate chilling. If the temperature is below 7°C then the plant is affected by the cold temperatures, with colder temperatures producing bigger effects. A temperature of one degree below the base temperature for one hour causes one Chill Hour to accumulate. If the temperature is 4 degrees below the base temperature for one hour then 4 Chill Hours accumulates and so on. One extra wrinkle is that below 0°C chilling is ineffective so chilling is taken as zero for temperatures below 0°C. By summing these hourly amounts of chilling over the winter we have a measure of how cold the winter was from the plant’s perspective.

The following table shows how many Chill Hours are accumulated for each hourly temperature reading from a temperature recorder for two different base temperatures:

Hourly Temperature Reading	Chill Hours with base temperature of 7°C	Chill Hours with base temperature of 10°C
9°C	0	1
8°C	0	2
7°C	0	3
6°C	1	4
5°C	2	5
4°C	3	6
3°C	4	7
2°C	5	8
1°C	6	9
0°C	0	0
-1°C	0	0
-2°C	0	0

For kiwifruit and apples a base temperature of 7°C is often used in the calculation of Chill Hours.

### **Richardson Chill Units**

A researcher - oddly enough with a last name of Richardson - noted that the most effective temperature for chilling was generally around 4°C with effectiveness falling away to zero at 0°C and to zero at around 14°C. He devised a Chill Unit which took into account this non-linear response to temperature by plants. A temperature of 4°C for one hour produces one Richardson Chill Unit which is the maximum chilling which can occur in one hour. Richardson Chill Units are calculated on an hourly basis and summed for the winter to provide an estimate of the amount of chilling affecting plants.

### **Richardson Chill Units with Negation of Chilling**

A number of researchers have made improvements to the original Richardson Chill Unit system including refining the temperature response curve, and allowing for the negation of accumulated chill units which can occur when daily maximum temperatures go above 14°C.