

CLARE VALLEY CLIMATE PROFILE

Prepared for

Grape and Wine Research and Development Corporation

by

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A division of Kirklinton Pty Ltd as trustee for Davidson Viticultural Consulting Trust

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1.0 OVERVIEW

The Clare Valley is a moderately warm low rainfall region compared with other premium wine producing regions in Australia. The table below summarizes the available data from the Region. This data should be used with caution due to the small number of recording sites and their relatively short history. In order to understand the Region more fully, it is suggested that a network of weather stations be installed at various sites in the Valley. This will in time allow a fuller understanding of the Clare Valley climatic profile.

Table 1: Climate Summary

	Clare High School	Clare Post Office	Sevenhill	Kirribilly	Polish Hill River
Elevation (m)	395	385	480	400	440
DD (standard)	1767	na	1891	1585	1465
DD (19/10)	1540	na	1646	1435	1342
DD (BEDD)	1513	na	1645	1331	1245
Mean January Temperature - MJT	22.1	21.6	22.4	20.81	20.46
Mean Ripening Month Temperature (March)	18.5	19.2	19	18.5	16.83
Mean Ripening Month Temperature (April)	14.8	15	16.2	14.15	12.44
Continentality Factor	14.5	13.4	13.8	12.99	13.49
Ave 9am RH (Oct-Apr)	60.1	55.7	na	61.6	na
Sunshine Hours (Oct –Apr)		na	na	na	na
Spring Frost Index	13.7	15.35	5.32	15.4	12.99
Mean Frost Incidence (Sept-Nov)	3.5	7.5	0.3	13.3	9.9
No days > 35°C (Oct - Apr)	17	16.1	13.75	16.7	14.1
No days < 0°C (Oct-Apr)	3	3	0	3.5	1
Annual Rainfall (mm)	554.7	632.1	568.6	565.5	667.3
Oct-Apr Rainfall (mm)	213.2	245.3	222.1	206.2	248.1
Ripening Month Rainfall (March)	16.9	25.4	26.7	15.96	21.8
Ripening Month Rainfall (April)	28.6	46.6	13.9	24.42	32.21
No of rain days (Oct-Apr)	42.5	44.3	na	45.85	Na

na	Unable to calculate index due to missing data

2.0 SOME INDICES USED FOR CLIMATE DESCRIPTIONS

2.1 Weather Station Data

There is limited data available in the Clare Valley for use in drawing up a climatic profile. There is one registered Bureau of Meteorology weather station currently recording in the Clare Valley. It has been operational for 11 years and is located at the Clare High School. Prior to this the Clare Post Office was the site where data was collected for 132 years. Gladstones (1992) makes reference to the relevance of data from the Post Office, due to its low lying location and proximity to buildings and roadways, suggesting that in theory most viticultural areas are not as warm as the recording site. Hence the ability of the region to grow world class Riesling and full bodied red, as opposed to the fortified wines that have been suggested by the climatic data.

Several other unofficial weather recording stations exist in the Clare Valley. The following table indicates the spread and duration of weather recording, including limitations on the data, throughout the valley.

Table 2: Location of Weather Stations

Site	Duration	Limitations to data
Clare Post Office (BOM)	132 years	Location in township not relevant to viticulture
Clare High School (BOM)	11 years	
Sevenhill	11 years	Daily measurements taken by a maximum/minimum thermometer
Watervale	2 years	Not long term data set
Auburn	6 years	Many gaps in data set
Kirribilly	16 years	
Polish Hill River	10 years	Weather Station located in frosty hollow
Spring Farm Road	3 years	Not long term data set

2.2 Elevation

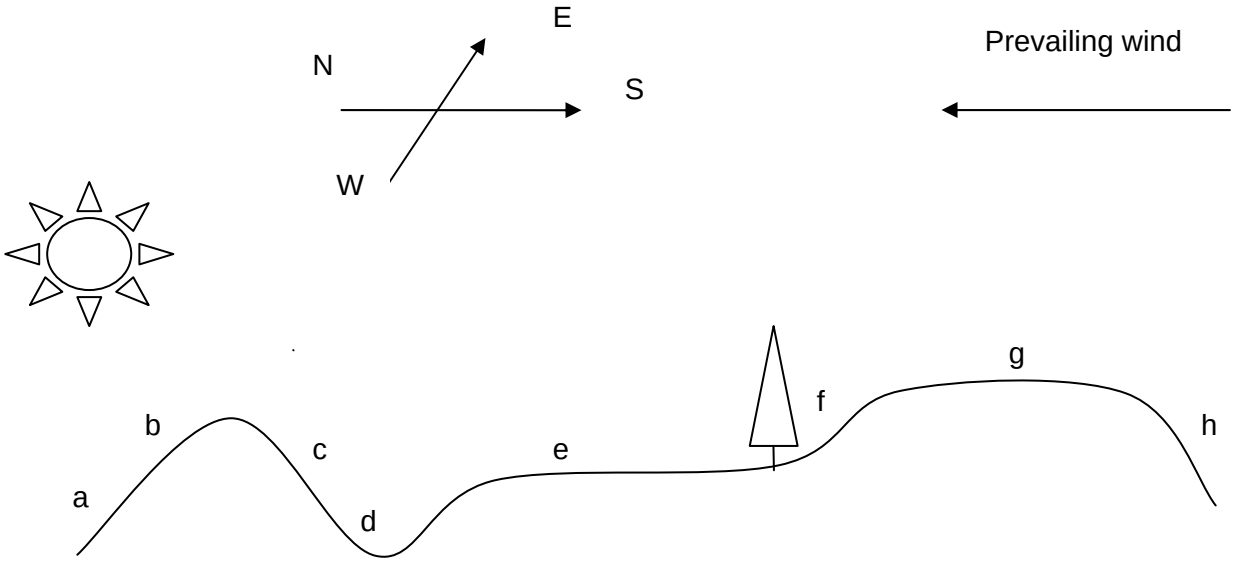
The Clare Valley has a nominal elevation of 400 – 500m. However there are areas such as Mount Horrocks (600m), Rhynie (252m) and White Hut (62m) which are significantly different from this nominal elevation, and hence may vary greatly in mesoclimatic conditions. The impact of elevation on mesoclimates and the ability to ripen grapes is due to several factors. Gladstones (1992) suggests that for every 100m increase in altitude there is a corresponding drop in mean temperature of 0.6^{o}C. This has a direct impact on the ripening ability of any given grape variety, which can be predicted by heat summation models, as demonstrated by Gladstones. The variation in mesoclimate due to elevation results in a 3.2°C drop in mean temperature from Rhynie to Mt Horrocks.

2.3 Aspect

As the Clare Valley is located within and around a narrow mountain range, a wide variety of slopes and aspects exists. This makes each individual vineyard within the region unique, and hence subregion classification difficult. Aspect influences the exposure of a vineyard to the sun and therefore its relative warmth in relation to the local climate. The warmest aspects are those facing north, north-east and east, while westerly aspects, which are cool in the morning but receive the harsh afternoon sun, are the next warmest aspects (Wine Industry Journal 1988). Southerly aspects are the coolest.

Slope, along with aspect, also has an important impact on the mesoclimates in the Clare Valley, not necessarily determining the ability for fruit to ripen, but more the effect on fruit quality, and the exposure to climatic extremes. The following diagram explains the effect of slope, aspect and elevation on potential fruit quality and climatic extremes.

Figure 1. Effect of aspect, slope and elevation upon vineyard mesoclimates (source Jackson and Spurling (1988)).



(a) This warm site will intercept more sunlight due to the lie of the land and will miss late spring and early autumn frosts as the cold air can drain to lower lying areas.
(b) This site has counteracted the advantages seen in (a) due to its increase in altitude, decreasing temperatures.
(c) This site is cold and will accumulate less heat in summer due to its elevation, exposure to prevailing wind and poor exposure to the sun. It may however miss spring and autumn frosts.
(d) This site is very cold and susceptible to frosts as cold air will drain to this point from the surrounding region.
(e) This site is frost prone but less than (d). Prevailing winds should be decreased by the hill and dense tree plantation.
(f) The dense tree planting at the base of the hill prevents cold air from draining away from this site, and hence a frost- free site has been lost.
(g) This site is warmer than (e) but the prevailing wind and increase in altitude may hinder the accumulation of heat in summer.
(h) Cold, like (c) above.

2.4 Temperature & Degree Days (DD)

2.4.1 Day Degree

There are three methods of calculating Degree Days: “Standard Base 10°”, “19/10” and “Biologically Effective Day Degrees (BEDD)”.

Degree Days refers to the summation of the mean monthly temperature above 10ºC. Degree Days is a temperature-time integration of growing season conditions (Smart 1979). Temperature related indices are commonly used for two reasons; temperature has a significant impact on plant growth, and it is one of the cheapest and easiest climatic indices to measure.

Indices have been devised from heat summation factors to predict the suitability of districts for grape production. The heat summations for climatic regions are listed by Winkler et al (1974)

2.4.2 Standard (Base 10)

Base 10 is calculated by the summation of the mean monthly temperature minus 10 and multiplied by the number of days in the month. 10ºC is used as the base temperature on the assumption that little or no growth occurs below 10ºC. This index is calculated for the fixed period of October to April. This has been identified as the standard HDD summation.

The standard Day Degree Summation ranges from 1891 at Sevenhill to 1465 at Polish Hill River. The Clare High School site closely follows Sevenhill with 1767, whilst Kirribilly has a standard day degree summation of 1585.

Table 3: Climatic Regions as described by Gladstones 1992

Region	Heat summation ºF	Heat summation ºC	Examples of Regions
I	less than 2500 DD	(less than 1371DD)	Coonawarra & Blenheim, NZ
II	2501 → 3000 DD	(1372 → 1649 DD)	Barossa Valley and Auckland, NZ
III	3001 → 3500 DD	(1650 → 1927 DD)	Bendigo & Lisbon, Portugal
IV	3501 → 4000 DD	(1928 → 2204 DD)	McLaren Vale & Madeira, Portugal
V	4001 DD or more	(2205 DD or more)	Hunter Valley and Fresno, USA

The Clare Valley can be classified as Region III, having 1760. The data from the Kirribilly and Polish Hill River stations indicates that these areas of the Valley fit into Region II. It must be noted that the Polish Hill River weather station is located in a frosty hollow. This is most likely responsible for the lower day degree accumulation. Anecdotal evidence suggests that there has never been a problem with ripening on any variety at the site; indicating that there is in excess of 1350 BEDD which is more similar to the other sites

2.4.3 19/10

Gladstones (1992) developed a different method, whereby any month with a mean temperature greater than 19°C or higher is truncated at 19°C; i.e. a maximum day degree summation of 279 is the highest summation possible for any month. Thus the 19/10 DD is the mean temperature (truncated at 19°C) minus 10°C, multiplied by the number of days in that month, and summed over the growing season.

The data suggests that the 19/10 figures for the sites used in this study are as follows. Care should be taken when comparing a site to the Polish Hill River site due to its low lying location.

The 19/10 Day Degree summation ranges from 1646 at Sevenhill, 1540 at Clare High School, 1435 at Kirribilly and 1342 at Polish Hill River.

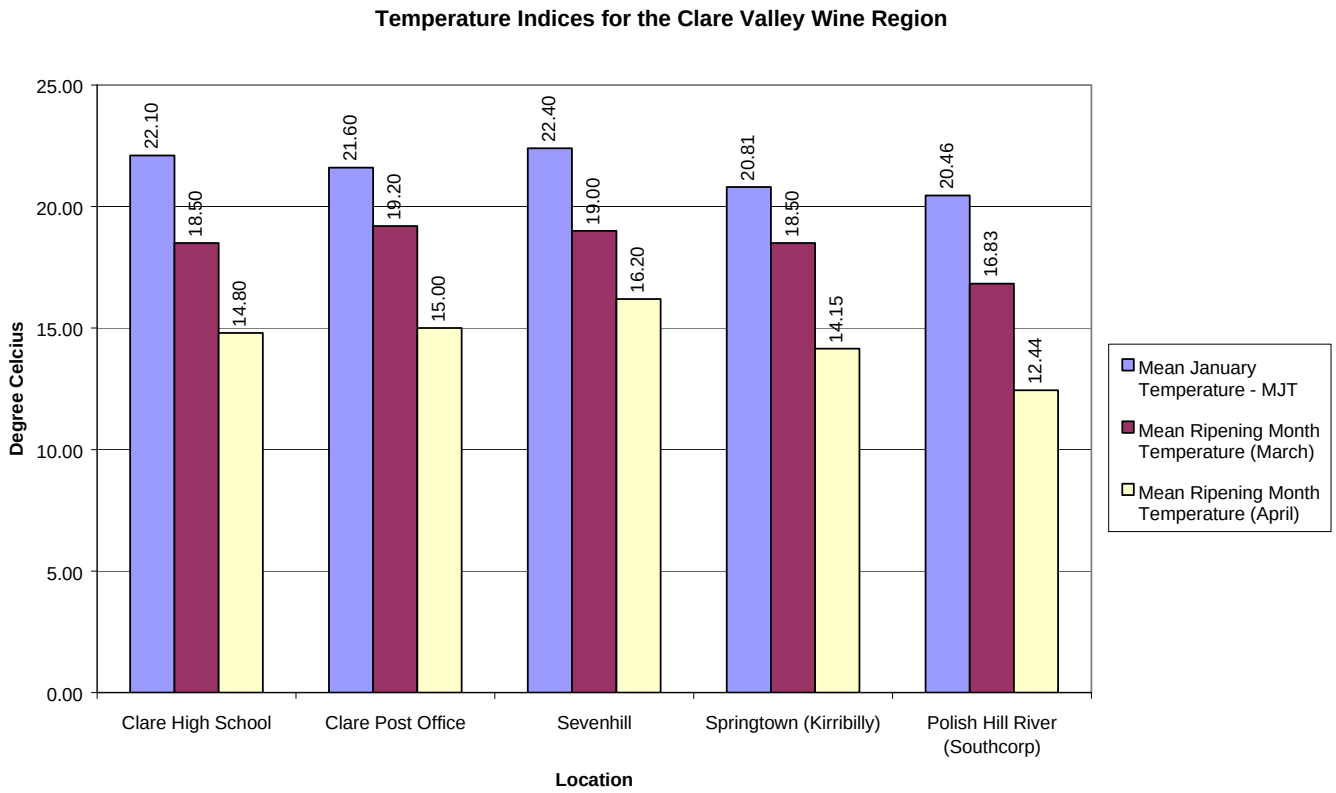
2.4.4 Biologically Effective Day Degrees (BEDD)

Biologically Effective Day Degrees (BEDD) is a climatic index that has been derived from the HDD summation. It limits summation to between 10°C and 19°C and also adjusts for latitude and daily temperature range. This climatic index is the most common and comprehensive temperature-time measure used in the Australian viticultural industry, and hence will be the main Day Degree summation referred to in this report.

Different varieties require different heat summations in order to ripen fruit fully. Examples given by Gladstones (1992) are:

Pinot Gris	1100 BEDD
Pinot Noir	1150 BEDD
Chardonnay	1150 BEDD
Sauvignon Blanc	1150 BEDD
Shiraz	1250 BEDD
Merlot	1250 BEDD
Cabernet Sauvignon	1300 BEDD
Grenache	1350 BEDD
Polish Hill River	1245 BEDD
Kirribilly	1331 BEDD
Clare High School	1531 BEDD
Sevenhill	1645 BEDD

The data suggests that Polish Hill River would be unable to ripen Cabernet Sauvignon and Grenache, and in some years may not be able to ripen Merlot. However, experience indicates that sites in this area can and do ripen Cabernet Sauvignon without any difficulty. Nonetheless there may be some cooler sites within the Polish Hill area which are unable to sufficiently ripen the later varieties in every year.



2.5 Mean January Temperature (MJT)

MJT is a simple calculation of how warm a specific site or region is, and is the average of the monthly maximum and minimum temperatures.

Throughout the Clare Valley there appears to be a 1.94°C difference in MJT (limited data available). As would be expected from the rankings of day degree summation, Polish Hill River has the lowest MJT (20.46°C) and Sevenhill has the highest MJT (22.4ºC). But the statistical significance of this cannot be tested due to the lack of data.

2.6 Mean Ripening Month Temperature (March & April)

Mean Ripening Month Temperature is defined as the mean temperature of the 30 days prior to the expected harvest date for any variety. Gladstones (1992) suggests that there is a broad association between mean temperature of the ripening month and the styles of wine which can be produced.

Sites with ripening month average mean temperatures below 15°C may or may not allow full sugar ripeness. Ripening month average mean temperatures of between 15°C and 21°C will generally allow for well balanced wines for dry table wines. Comments from winemakers and grape growers confirm that wines which are made from grapes grown closer to 15°C tend to be lighter bodied, more fresh and delicate, whilst wines produced from grapes with mean ripening month temperature closer to 21°C are likely to be more full bodied.

2.7 Continentality

Continentality is an index which measures the difference between the mean temperature of the warmest and coolest months. It is commonly overlooked when comparing climatic conditions of sites. Continentality is often used as a measure of the moderating influence of large water bodies, and the measure can range from 8.7 in Hobart, Tasmania to 16.3 in Cowra, New South Wales. Other countries experience far greater continentality than in Australia, for example, 22.8 Egar, Hungary. (The higher the continentality, the less the effect of the ocean.)

In the Clare Valley Region, the Clare High School site has the highest continentality measure, (14.5), whilst Kirribilly has the lowest (12.99), but this is not likely to be statistically different, merely a reflection of the limited years of recording. The Clare Post Office, Sevenhill and Polish Hill River are all relatively similar at 13.4, 13.8 and 13.49 respectively. These continentality factors are similar to regions such as: Stanthorpe in Qld; Malaga, Spain; Cessnock, Hunter Valley; and Merbein, Victoria.

2.8 Average 9am Relative Humidity (%RH)

Relative humidity is an important climatic index for determining disease risk, irrigation requirements and potential for heat damage due to persistence of hot dry winds. The 9am %RH of January is used as an index of relative humidity for the season (Gladstones 1992). There have been suggestions that superior wine quality is associated with greater continentality (Gladstones 1992), however this is controversial and not generally accepted in the international winemaking community.

For the purposes of this climatic summary the average 9am RH over the growing season has been used as the index as it accounts for more humid conditions experienced during flowering and harvest. There is little variation in humidity records between the sites, with 55.7% at Clare Post Office and 61.6% at Kirribilly.

According to Dry and Smart (1988) **a moderate to high incidence of bunch rot** can be expected when the following conditions occur in the ripening month

Rainfall exceeds 60mm
Rain days exceed 8
9am RH exceeds 60%

These conditions are likely to be of rare occurrence in the Clare Valley.

Dry & Smart (1988) also suggest that **a moderate to high incidence of downy mildew can be expected** when the following conditions occur throughout the season:

Rainfall (Oct – Mar) exceeds 200mm
Rainfall (Nov) exceeds 40mm
Rain days (Oct-Mar) exceed 40
9am RH (Nov) exceeds 60%

These conditions are not generally expected to occur in the Clare Valley, although in individual years a moderate to high incidence of downy mildew may occur.

2.9 Sunshine Hours

The amount of sunshine at the time of flowering has a direct impact on fruit set via enhanced photosynthesis. Sunshine hours can be considered at specific times during the growing season, or over the seven month growing season period.

A figure of 1250 sunshine hours from October to April is a generalised requirement for viticulture according to Gladstones (1992) and Becker (1997). This equates to approximately 5.9 hours per day during the growing season. The Clare Valley exceeds this requirement with an average of 1750 sunshine hours observed (Gladstones 1992) or 8.3 hours per day during the growing season. Within the Clare Valley there is no official measurement of sunshine hour. Some of the more sophisticated Automatic Weather Stations measure day length by means of a global radiation sensor which measures watts/m^2. A sunshine hour as measured by the Bureau of Meteorology is the length of time each that bright sunshine will burn a hole in cardboard when reflected by a magnifying glass. Hence the two measurements are not comparable due to the lack of data available for sunshine hours, no further consideration is given in this report.

2.10 Spring Frost Index

Gladstones (2000) has established an index known as Spring Frost Incidence (SFI). The SFI is calculated as the spring months' average mean temperature minus its average lowest minimum temperature, recorded between the months of October and November. Clare Post Office and Kirribilly have the lowest chance of frost, whilst Polish Hill River and the Clare High School have higher chances of frost.

The data suggests that Sevenhill has a Spring Frost Index of 5.32. This result is questionable. The temperature data is collected by a maximum and minimum thermometer, and hence may not be as accurate as other measurements taken in the Region.

When comparing this SFI data with that collected by Gladstones (1992), frost risk in the Clare is similar to that experienced in other moderate frost risk areas such as Coonawarra, Adelaide Hills, Reims (France), Fresno (California) and Blenheim (NZ). SFIs in Australia range from 9.6 in Hobart, Tasmania to 15.8 in Cowra. Generally, the closer a region to a humid coastline environment, the lower the frost risk.

2.11 Mean Frost Incidence

The mean frost incidence is the average number of times that the temperature will reach 2.2°C or below at the recording station in the months of September to November. The figure of 2.2°C is used by the Bureau of Meteorology as a measure of temperature in the Stephenson screen which reflects a ground temperature of 0°C.

Kirribilly has the highest incidence of frost in the Region, it experiences an average of 13.3 frosts in the September to November period. Polish Hill River has a mean frost incidence of 9.9 days. The Clare Post Office has the next highest incidence of frost, having on average 7.5 days of frost in the specified period. The incidence at the Clare High School site is much lower (3.5 days), most probably due to slightly higher elevation. The data suggests that Sevenhill has only 0.3 days of frost during September to November; anecdotal evidence confirms this. Sevenhill experiences easterly winds which will generally disturb any pooling of cold air. The weather recording site is nearly 100m higher in elevation than the Clare Post Office which would also be responsible for the reduction of frost incidence at Sevenhill..

Unfortunately the data from Auburn and Watervale cannot be used in this project due to significant gaps in the data or lack of long term data. However more data would be interesting and of value to growers in assessing frost risk through the valley. Until more accurate and detailed data is collected this cannot be achieved.

2.12 Number of Days > 35°C

The number of days above 35°C is an important measure to enable grape growers to determine, on average, the number of times that the vines' physiological function may be reduced in the growing season

This will occur on average 16-17 times per year in the Clare Region. January and February are the times when this is most likely to happen as these are the warmest months of the year. The result of this can be devastating, especially if irrigation is supplementary and the water status of the soils is low (as generally is the case for most Clare vineyards). Depending on the prior level of water stress that the vine is experiencing, the result may range from complete defoliation to the loss of growing tips only.

2.13 Rainfall

Rainfall is an important factor to consider in the climatic evaluation of a viticultural region because of its impact on irrigation requirements and the potential disease risk associated with ripening month rainfall.

Rainfall data is collected by the Bureau of Meteorology at many more stations than are other climatic indices. Therefore a clearer map of rainfall distribution can be made for the Region.

The annual rainfall for Clare is moderate for a premium wine producing area with an annual range of 465mm to 650mm. The comparison with other areas is made below:

Coonawarra	581mm
Barossa	500 mm
Mt Barker SA	766 mm
Yarra Valley	899 mm
Pyrenees	600 mm
McLaren Vale	522 mm

2.13.1 Annual Rainfall

The annual rainfall in the Clare Valley ranges from 667.5 mm at Polish Hill River to 465.2 at White Hut, generally of winter incidence.

Annual Rainfall is a useful index in the Clare Valley in addition to Growing Season rainfall and ripening month rainfall as it gives an indication of the amount of soil water refill. Generally soils in the Clare Valley have a high water holding capacity and hence will retain relatively high volumes of winter rainfall which becomes available to the vines early in the season.

2.13.2 Rainfall (October – April)

Growing season rainfall is measured as the total rainfall for October to April, and is useful for the aridity index (irrigation requirements) and disease risk assessment. The distribution of annual rainfall and growing season rainfall are similar.

The growing season rainfall in the Clare Valley ranges from 273.6 at Armagh to 152.4 at White Hut.

2.13.3 Ripening Month Rainfall (March & April)

The Ripening month rainfall index is used mainly to predict the disease risk associated unfavourable with ripening month conditions, particularly for diseases such as downy mildew and Botrytis. It is the summation of rainfall (mm) for the 30 days preceding the expected harvest date.

The March ripening month rainfall in the Clare Valley ranges from 16mm at Kirribilly to 27.3mm at Watervale. The April ripening month rainfall is slightly different with Sevenhill receiving only 13.9mm and Watervale 48.8mm

The table below is a summary of each site in the Clare Valley which measures rainfall and compares annual, growing season and ripening month values.

Table 4: Comparison of Rainfall categories and distribution in the Clare Valley

Site	Latitude ° ‘ S	Annual (mm)	Growing Season (mm)	Ripening Month - March (mm)	Ripening Month - April (mm)
White Hut	33 47	465.2	152.4	20.1	28.2
Hilltown	33 41	474.2	181.4	16.6	30.8
Farrell Flat	33 49	475	188.5	17.6	32.6
Manoora	34 00	485.8	196.2	19.9	33.8
Rhynie	34 11	505	208.7	22.6	33.5
Geralka	33 37	514.2	198.6	17.4	34.6
Kybunga	33 54	519.2	213.2	22.6	32.9
Neagles Rock	33 5	544.5	185.9	17.6	14.5
Calcannia/Barinia	33 44	544.6	210	17.5	34.9
Clare High School	33 49	554.7	213.2	16.9	28.6
Kirribilly	33 49	565.5	206.2	16	24.4
Sevenhill	33 52	568.6	222.1	26.7	13.9
Clare Caravan Park	33 51	573.9	230.8	19.1	28.1
Bungaree	33 44	580.2	227.5	23.1	42.1
Auburn	34 1	594.2	236.4	25.9	42.9
Mintaro	33 54	597.6	221.8	21.5	37.6
Hill River	33 5	629.2	238.9	23.6	45.8
Clare Post Office	33 5	632.1	245.3	25.4	46.6
Armagh	33 51	652.8	273.6	25	46.3
Watervale	33 57	653.9	257.5	27.3	48.8
Polish Hill River	33 53	667.5	248.1	21.8	31.9