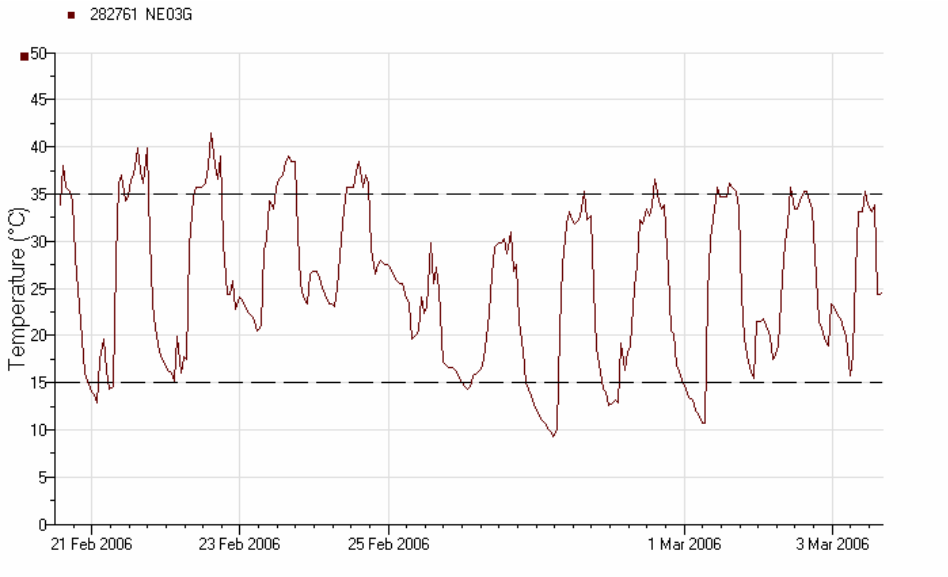
GrapeLinks
Viticultural Knowledge Management

Australian Government
Grape and Wine Research and Development Corporation

Benchmarking NE Victorian Shiraz Season 05/06



Diurnal bunchzone temperature curves

REPORT to

The Grape and Wine Research and Development Corporation

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Abstract

A benchmarking study was carried out on 26 Shiraz vineyards in 5 regions of NE Victoria. The aim of the project was to test for a 2nd year the effectiveness of new ways of vineyard scoring and fruit quality assessments, to find common pointers for good grape and wine quality outcomes for a full bodied Shiraz wine style, to enable viticulturists and winemakers to change practice which may lead to better vineyards, better grapes and better wines and to raise issues for further surveys and research trials in NE Victoria.

New vineyard scoresheets designed by GrapeLinks placed greater emphasis on veraison measurements of vine balance, vigour, bunch leaf cover and leaf health as well as early cane lignification in order to give growers a chance for timely adjustments if needed. Berry Sensory Assessment (BSA) was carried out in all vineyards pre harvest by the field coordinator. Electronic data loggers owned by the growers were installed by the field coordinator in a representative spot of the vineyard in the canopy at the bunch zone for the observation of veraison to harvest daily bunch zone temperatures. Berries from randomly taken bunch samples were analysed for weights, anthocyanins, flavonols, total phenolics Baumé, TA and pH by Vintessential Laboratories. Grape processing and fermentation data for the fruit was supplied by the relevant winemakers. Wines were chemically analysed after fermentation by Vintessential Laboratories. Five-month-old wines were judged by Nick Bulleid and a local winemaker. Extensive data analysis was performed by GrapeLinks.

The diversity of rather contrasting sites and growing practises was again helpful to show interrelations between sites/management practices and quality pointers. It was extremely useful to have a second season, which was considerably dryer and hotter. Measurements of fruit load per shoot or vine balance (leaf area per g fruit weight) were more precise pointers to extremes in vineyard performance than visual assessments of “vigour” or “yield/ha”. Indications of physiological processes like acid depletion or sugar loading (calculated by dividing harvest values by hangtime) were more useful than TA or Be at harvest for the interpretation of plant function and success of changed management practice, eg speed of acid depletion was significantly correlated to colour at harvest.

Bunchzone temperature measurements from the data loggers were analysed in various ways. Summative degree hours between veraison and harvest showed in this hotter year that hangtime played a crucial role for the sum of heat exposure. Daily average bunchzone temperatures eliminate the differences between hangtimes and give a good picture of the grape’s general environment. However the absence of extremes (summative hours above 35C and below 15C) was found more crucial for good grape quality. Diurnal bunchzone curves revealed the effect of canopy management and site on the bunch exposure at different times of the day and showed eg. the duration of heatloads. Leaf cover (measured by field assessment and flavonol concentration in berries) played a crucial role with respect to bunchzone temperatures in all locations. Similar to results from last year, bunches that had experienced fast warm-up in the morning with low heatloads in the afternoon achieved best berry anthocyanin results. Lack of bunch warmth in the morning due to leaf shade and also heat in the afternoon resulted in low anthocyanins/g FW. Bunches with long cold and long hot hang times had low colour per day of hangtime. Bunches with short hang times in beneficial conditions had best colour/day of hangtime.

There was a trend that higher anthocyanins in grapes led to higher anthocyanins in wine, in particular with longer extraction times. Total phenolics were this year considered as a less suitable pointer for grape and wine quality as they were in 06 not measured from peeled skin extracts but rather after the extraction of blended whole grapes. Thus there was no linear relationship between berry and wine total phenolics. Shrivelled berries were outside the norm with respect to many quality traits.

BSA proved again a very useful tool to discriminate berry potential. Pulp and skin maturity was generally higher this year, independent of sugar ripeness and more influenced by bunch microclimate than by seasonal variation. Seed maturity was unrelated to all measured traits and generally low. There was this year a significant correlation between good BSA scores (seeds excluded) and lower average bunchzone temperatures (lack of heatloads) either caused by better bunchzone management or by shorter hangtime avoiding late season heat loads.

There was some trend for higher anthocyanins in wine with higher anthocyanins in berries over 2 years but no relationship existed for total phenolics this year as seeds were extracted differently in ground up berries and in winemaking.

Wine scores depended strongly on the sum of red fruit rating and less on colour and very little on tannin softness. With higher amounts of cumulative degree h, the chances of achieving high red fruit scores in young wine were diminished and provided no drought stress, the chances of achieving softer tannins were increased. Wine scores above 15.5 were reached between 20,000 and 26,000 degree h in the absence of problems. Last year (colder nights) the best wine scores were reached in a bracket of 23,000 – 30,000 cumulative degree hours. Very cold sites (devised by low av. degree h above 0C) can result in good wine scores with very long bunch hangtimes in appropriate canopy and vine management. Cool sites or leafy vineyards need longer hangtimes. Bronze medal winning wines in this sector have more colour, tannins and fruit through better site adapted canopy management. Warm sites yielded some wines of low scores with cooked aromas and rough tannins, but also wines with excellent scores brought about by short hangtimes and no extreme water shortage.
In many vineyards, practice change had been undertaken in response to last year's findings (mainly with respect to canopy management) and an improved grape and wine quality could be assessed as a consequence.

Executive Summary

The project was carried out by

- A consultant (E. Winter)
- A field coordinator (S. Lowe)
- A field assistant (P. Blackshaw)
- Vintessential Laboratories (M. Vallesi)
- Bulleid Consulting (N. Bulleid)
- The King Valley Vignerons Inc.
- The participating growers and winemakers

Support was received from

- Grape and Wine Research and Development Corporation funding the project though the RITA program.
- The Vineyard owners for payment of the data loggers.
- King Valley Vignerons Inc. for meetings and administrative work.

Vineyard locations

- The 26 vineyards were located in the Alpine Valleys, Beechworth, Glenrowan, King Valley and Rutherglen Wine Regions of the North East Victoria Wine Zone.
- Vineyards and managers were basically the same as in 2003/04 and 2004/05
- The vineyards were spread over a wide range of altitudes and the slopes and inclinations varied in the valleys and on the hills.

The methods used were

- Mesoclimate records from Bureau of Meteorology for all regions
- Information on location, slope, aspect, row orientation, trellis type, rootstock, clone, row and vine spacing, pruning and water management for each vineyard (*growers*).
- Vineyard assessments at veraison and pre harvest on GrapeLinks vineyard scoresheets (*Field coordinator*).
- Berry Sensory Assessments of all vineyards pre harvest (*Field coordinator*).
- Data loggers in the bunch zone for the observation of veraison to harvest bunch zone temperatures (*Tinytag Loggers*, *Hastings, Port Macquarie*).
- Berry chemical analysis for anthocyanins, flavonols, total phenolics, Baumé, TA and pH and weight of grapes at harvest. (*Vintessential*).
- Grape processing and fermentation data (*Winemakers*).
- Wine chemical analysis from samples after fermentation (*Vintessential*).
- Assessments of five-month old wines by a Master of Wine *(Bulleid Consulting*) and a local winemaker.
- Extensive data analysis by a plant physiologist *(GrapeLinks).*
- Grower information assemblies before and after the duration of the project *(Association).*

Main findings were:

- The diversity of rather contrasting sites (Tab.1) and growing practises was again helpful to show interrelations between sites/management practices and quality pointers.

- It was extremely useful to have a second season, which was considerably dryer and hotter (see climate section). It showed much clearer the detrimental effects of afternoon heatloads due to site conditions (hot winds or cool breezes, ridges or valleys etc) but much more due to canopy management and water status of the vines (lack of water led to partial defoliation in the bunchzone and thus higher than intended heatloads).

- Digital photography was a very useful tool to assist in the interpretation of the dataloggger curves.

- Vineyard scoring at veraison and pre harvest (Tab.2) was again important. Measurements of fruit load per shoot or vine balance (leaf area per g fruit weight) were more precise pointers to extremes in vineyard performance than visual assessments of " vigour" or "yield/ha". To know the vine balance and the important effect of crop load this year was crucial.

- Indications of physiological processes like acid depletion or sugar loading (calculated by dividing harvest values by hangtime) were more useful than TA or Be at harvest for the interpretation of plant function and success of changed management practice, eg speed of acid depletion was significantly correlated to colour potential at harvest.

- In many vineyards, practice change had been undertaken in response to last year's findings (mainly with respect to canopy management). Many vineyards have improved their grape quality as a consequence.

- Bunchzone temperature measurements (Tab. 3) proved again to be an affordable tool to adapt viticulture to seasonal conditions. Downloads from the data loggers were analysed in various ways.

- Summative degree hours between veraison and harvest showed in this hotter year that hangtime played a crucial role for the sum of heat exposure. Some crops were fortunately harvested much earlier than last year due to good sugar loading (high leaf to fruit ratio from abundant leaves, lower bunch numbers per shoot and in some cases from poor set or bunch thinning).

- Daily average bunchzone temperatures eliminate the differences between hangtimes and give a good picture of the grape's general environment. However the absence of extremes (summative hours above 35C and below 15C) was found more crucial for good grape quality.

- Diurnal bunchzone curves revealed the effect of canopy management and site on the bunch exposure at different times of the day and showed eg. the time and duration of heatloads. Leaf cover (measured by field assessment and flavonol concentration in berries) played a crucial role with respect to bunchzone temperatures in all locations. Similar to results from last year, bunches that had experienced fast warm-up in the morning with low heatloads in the afternoon achieved best berry anthocyanin results.

- Lack of bunch warmth in the morning due to leaf shade or heat in the afternoon resulted in low anthocyanins/g FW. Bunches with long cold and long hot hang times had low colour per day of hangtime. Bunches with short hang times in beneficial conditions had best colour/day of hangtime.

- There was a trend that higher anthocyanins in grapes led to higher anthocyanins in wine, in particular with longer extraction times.

- Total phenolics were this year considered as a less suitable pointer for grape and wine quality as they were in 06 not measured from peeled skin extracts but rather after the extraction of blended whole grapes. Thus there was no linear relationship between berry and wine total phenolics.

- Shrivelled berries were outside the norm with respect to many quality traits.

- BSA proved again a very useful tool to discriminate berry potentials. Pulp and skin maturity was generally higher this year, independent of sugar ripeness and more influenced by bunch microclimate than on seasonal variation. Seed maturity was unrelated to all measured traits and generally low. There was this year a significant correlation between good BSA scores (seeds excluded) and lower average bunchzone temperatures (lack of heatloads) either caused by better bunchzone management or by shorter hangtime avoiding late season heat loads.

- There was some trend for higher anthocyanins in wine with higher anthocyanins in berries over 2 years but no relationship existed for total phenolics this year as seeds were extracted differently in ground up berries and in winemaking.

- Wine scores depended strongly on the sum of red fruit rating and less on colour and very little on tannin softness.

- With higher amounts of cumulative degree h, and no drought stress, the chances of achieving high red fruit scores in young wine were diminished and the chances of achieving softer tannins were increased.

- Wine scores above 15.5 were reached between 20,000 and 26,000 degree h in the absence of problems. Last year (colder nights) the best wine scores were reached in a bracket of 23,000 – 30,000 cumulative degree hours.

- Average degree h give a good indication of bunchzone temperature category. Very cold sites with very long hangtimes with appropriate canopy management (low leaf cover on east or south side) can result in good wine scores. Cool sites or leafy vineyards need longer hangtimes or else their wine descriptor diagrams look flat. Longer hangtimes in warm dry years need better irrigation management. Bronze medal winning wines in this sector have more colour, tannins and fruit through better site adapted canopy management. Warm sites contain the danger of drought stress or over-exposure related failures with wines of low scores having cooked aromas and rough tannins. Excellent scores can here be obtained with short hangtimes and no extreme water shortage.

- Lack of irrigation water forced some vineyards to suboptimal water management. This led to changed bunchzone climates due to partial defoliation of the bunchzone. The interrelation of canopy management and water management was a major learning experience this year and should be reinforced for future studies.

- In many vineyards, practice change had been undertaken in response to last year's findings (mainly with respect to canopy management) and an improved grape and wine quality could be assessed as a consequence.

Background

The benchmarking surveys of Shiraz vineyards in Victoria started in Central Victoria in 20001/02 with follow-up surveys in 2002/03 and 03/04. The studies used a score sheet system developed and kindly made available by Southcorp. In 2003, three North East Victorian (Alpine Valleys, King Valley) Southcorp growers participated in that project. In 2004 a RITA project was undertaken by North East Victorian regions, which allowed a greater number of growers and winemakers to participate, and encompassed all five G.I. regions. A summary of the outcomes of all RITA Shiraz benchmarking projects so far was undertaken by GrapeLinks and published in Australian Viticulture January/Feb 05. It was concluded that old myths of quality relevant vineyard practices did not hold true. Furthermore, to find relevant groups of quality pointers, new scoresheets were needed and adapted to the findings of past years. Also quality pointers cannot be determined by general statistical analysis only. Cause-effect relationships must be established on single vineyard basis. This new benchmarking method was successfully undertaken for the 04/05 season and reported to GWRDC (*Winter and Lowe, 2005*) and at international conferences (*Winter, Lowe and Bulleid, 2006*)

The challenge of a benchmarking survey is the variety of terroirs, climates, rootstocks, clones and plant arrangements. Management practice in the region is well advanced but shows differences and winemaking is very heterogenous. Previous scoresheets mainly tracked down negative pointers to grape quality to lift management practices, in particular of new growers. With experienced growers and well established vineyards the challenge is to find pointers for good grape and wine quality independent of site and plant variability. As no identical winemaking was possible much information on winemaking was needed which again helped for the adoption of best practice from the vine to the wine.

Besides the necessary absence of negative specifications a prerequisite of grapes for good wines is that they are not only sugar ripe but also have a minimum amount of acidity left and ripe tannins and aromas as well as good colour. In most Australian climatic conditions sugar ripening is not an issue – on the contrary, often sugar ripeness is reached well before aroma and tannin ripeness. Sugar concentration in grapes is largely dependent on the optimum conditions of the sugar factories (leaves), their active surface with respect to the weight of the fruit per shoot, competing sugar sinks and the availability of water to transport the sugar as well as the loss of water from the berries late in the season to the air or back into the plant. Vine balance, young to old leaf ratio and leaf exposure plays a big part of these prerequisites. This was included in the scoresheets on the benchmarking in 2004/05, with particular emphasis on leaf health later in the season.

Tannin quantity cannot be easily measured thus grapes are normally assessed for total phenolics and anthocyanins as an indicator for tannin and colour potential in wines. Tannin intensity and softness and aroma potential can be assessed in grapes by Berry Sensory Assessment, which has been proven in 04/05 to give a good correlation with wine potential. Aromas and aroma precursors in berries have been shown to depend on optimum temperatures to be produced (and also not to be lost). Temperatures may likewise be important in tannin development and ripening. Bunch zone temperature measurement is now cheap and accessible and was of great help in the assessments of the benchmarking results in 04/05.

This study was highly supported by the funding bodies, viticultural association, consultants and viticulturists and winemakers as it was hoped that the interesting results of the previous year can be confirmed under different seasonal conditions so that some universal method can be elaborated on how to adapt growing practices to sites.

The Project in 05/06

Material and Methods:

Vineyard selection and coding

Twenty-six vineyards - approximately five from each region - again participated. The vineyards cover a broad range of small and large sites, and are a mixture of both winery owned and independent grapegrower operations. Vineyards were coded by number and regions, and all further data generation and processing was strictly anonymous by code only. A few of the vineyards of last year did not participate again and they were replaced by new members of the region for which the vineyard code received an additional N.

Vineyard locations

The vineyards are located in valleys and plains on the northern slopes of the southern end of the Great Dividing Range in South East Australia. Soils span a diversity of origin from volcanic to granitic and alluvial.

Vineyards have been managed in these valleys for more than 15 years. Site potentials are well known, and management practices are well established.

Beechworth, with an average elevation of 400m and its great variability of sites with respect to their position on the plateau had 2 sites on steep slopes facing n and w and 2 on only 3% slope.

Alpine Valley with altitudes ranging from 200 - 500 m with 3 vineyards on some rather steep slopes (see Table 1), and one on flat terrain, mainly nw/se or ne/sw aspects and one rain fed vineyard.

King Valley vineyards were located at altitudes between 250 m to 550 m with a diverse range of aspects and with slopes of 10-15% or lower.

Glenrowan vineyards are located at the foothills of the Warby Ranges at approximately 200 m of altitude and faced mainly s/w or n/w.

Rutherglen vineyards (and “others”) were located on open plains at 150-200 m, had mainly north-westerly aspects and had 10% slope or less.

Climatic information

Climatic data both, long term average and recent consisting of temperature and rainfall was obtained from the Bureau of Meteorology for the King Valley, Beechworth and Rutherglen regions. Temperature and rainfall data was also obtained from a winery in the Glenrowan region and DPI Research Station in the Alpine Valleys region (see graphs in “Results”).

Site information and vineyard characteristics
Site information including data on slope, aspect and rainfall before and after veraison was collected from the growers as well as Information such as planting date, trellis type; row orientation, row spacing and vine spacing, rootstock, clone, pruning method, harvesting mode and irrigation method and assembled into **Tab. 1** Yield was included after harvest.

Assessment locations
Each block was divided into 2 sections, each encompassing one half of the total number of rows. The sampling technique involved "zig–zagging" along each side along the length of pre determined and marked rows in the section.

Vineyard scoring
Scoresheets developed by GrapeLinks incorporated veraison measurements and pre harvest assessments (**Tab. 2**). During the veraison assessment 20 shoots were selected along the marked rows by the field assessor and measured for average shoot length, active leaf area (according to *Winter and Whiting, 2004*), number of active leaves, proportion of young to active leaves, number of actively growing tips, average bunch number per shoot, leaf cover on front and back of bunches (noting which side front was facing), the condition of mature leaves and percentage of lignification on the canes.
At harvest the condition of the four oldest and younger leaves was assessed, the leaf cover over bunches was noted and growers recorded average bunch weight. From the active leaf area per shoot and the bunch number and weight, vine balance could then be calculated *(Winter and Whiting, 2004)*.

Bunch climates Data loggers (*Tinytag*, Hastings Data Loggers, Port Macquarie) purchased by the growers were attached to the vine row-facing side of the posts within the canopy at the bunch zone and measurements were taken hourly from veraison to harvest **Tab. 3.** Data were downloaded with the appropriate software and cable onto a computer by the field assessor and processed for analysis by GrapeLinks. Ripening phase degree hours were calculated from the hourly readings of data loggers for the period from veraison to harvest from a base of 0^{o}C.

Phenology
Dates of 50% flowering, veraison and harvest were recorded in the vineyard scoresheets and phenology was calculated.

Berry sensory assessment
Field Berry Sensory Assessment was carried out pre harvest (**Tab. 4**) by the field coordinator (to ensure comparability) choosing 6 bunches and assessing them according to *Winter et al. 2004*.

Grape sampling
Pre harvest berry samples were taken on each side along the complete row covering top and bottom parts of hills. For each vineyard, 25 bunchlets (8 - 10 berries) were selected from the top, middle, bottom, inner and outer parts of the bunch and the top, middle and bottom of the fruiting zone of the canopy for berry analysis (**Tab. 5**).

Grape analysis

One representative grape sample per vineyard were placed in labelled plastic bags by the field assessor and sent by express post to *Vintessetntial Laboratories, Dromana, VIC*. The samples consisted of 25 small bunchlets (of 10 or 12 berries each) collected across the chosen transect.

At the laboratory, all berries were removed from the rachis by hand and placed into a tray and gently mixed by hand. Berries from different areas within the container were selected to make up the required sample size, (eg, 100 berries – 100 g). The numbers of berries was recorded and they were placed into a tared container, and the total berry weight was recorded to at least two decimal places.

The berry sample was added to the homogeniser (Waring, Model 8011ES) and processed for 30 seconds on slow speed, and then for 60 seconds on high speed. Once homogenised, the samples were processed within 4 hours. Into a pre-tared 10ml plastic centrifuge tube 0.95 to 1.05 g of the homogenate was placed and the weight recorded. Then 10 mL of 50% ethanol (6.2) was dispensed into the tube. The homogenate was agitated by inverting every 10 minutes over a period of one hour ensuring that mixing is efficient, and that the pellet does not become lodged at the bottom of the tube.

Centrifugation (Centurion Model E25B5 or similar, capable of a radial centrifugal force (RCF) of at least 1800 g) of the homogenate/extract mixture at 1800g (3800 rpm) for 10 minutes was carried out and the supernatant was from then on termed the "extract". After the transfer 200 uL of the extract to a 10 mm path-length quartz cuvette, 3.8 mL of 1.0 M HCl (6.1) was added and mixed by covering with Parafilm. Incubation at room temperature lasted for at least 3 hours but no more than 24 hours. The absorbance of the acidified diluted extract was measured with an UV/VIS Spectrophotometer (Shimadzu 1201) at 700, 520, 360, 320 and 280 nm using a cuvette filled with 1.0 M HCl (6.1) as the blank.

Calculations were according to the formula:

$$\text{Anthocyanins (mg/berry)} = \frac{A520 \times DF \times V \times m \times 1000}{500 \times 100 \times M \times n}$$

$$\text{Anthocyanins (mg/g)} = \frac{\text{Anthocyanins (mg/berry)}}{\text{mean berry weight (g)}}$$

$$\text{Total Phenols (AU/berry)} = \frac{A280 \times DF \times V \times m}{100 \times M \times n}$$

$$\text{Total Phenols (AU/g)} = \frac{\text{Total Phenols (AU/berry)}}{\text{Mean berry weight (g)}}$$

Where A520 = Absorbance at 520 nm, A280 = Absorbance at 280 nm
DF = Dilution factor (20 if mixing 0.2 ml extract with 3.8 mL of 1.0M HCl).
V = Extract volume (mL). (If Homogenate weight is 0.95 to 1.05 g, then extract volume is taken to be 10.5 mL)
m = Total berry mass (g), M = Homogenate mass (g) and
n=Number of berries in sample

Post pressing wine analysis

A sample of wine after fermentation was collected by the field assessor from the wineries and sent to Vintessential Laboratories. There each wine sample was clarified by centrifugation and then diluted 1:100 with 1M HCl and equilibrated for 4 hours to allow maximum colour development. The diluted sample is then read at 520 and 280 nm. Results (after correction for dilution) are expressed as absorption units or eg. as anthocyanins based on the following formula:

$$\frac{\text{ABS at 520} \times 101 \times 1000}{50} = \text{Anthocyanins g/L}$$

where ABS at 520 is the absorbance at 520 nm, 101 is the dilution factor for the wine (large dilution needed to enable measurement in 10mm cell) 1000 is conversion g to mg, 50 is absorbance of 1g anthocyanins in 1L of solution. (In grape calculation, 500 is used, being a 1g solution per 100 mL)

Wine making procedures

Procedures during commercial wine making including crushing, additions, soaking, fermenting and pressing were given in questionnaires by the collaborating winemakers for each vineyard code and are listed in **Tab. 3**.

Finished wine assessments

Wines were made as separate batches from the vineyards, not blended with wines from other locations or varieties and judged (after only 5 months) by a Master of Wine (N. Bulleid, Bulleid consulting) and a local winemaker for the intensity of mouthfeel and aroma sensations, colour, hue and general wine score. Results are presented to the grapegrowers and winemakers in the afternoon after the tasting had taken place, and leaflets with the data are distributed for insertion in the report.

Results

The sites

The 26 vineyards were spread over a wide range of altitudes and in valleys and on hills. The map shows the locations of the regions:

Fig. 1: The sites of the vineyards

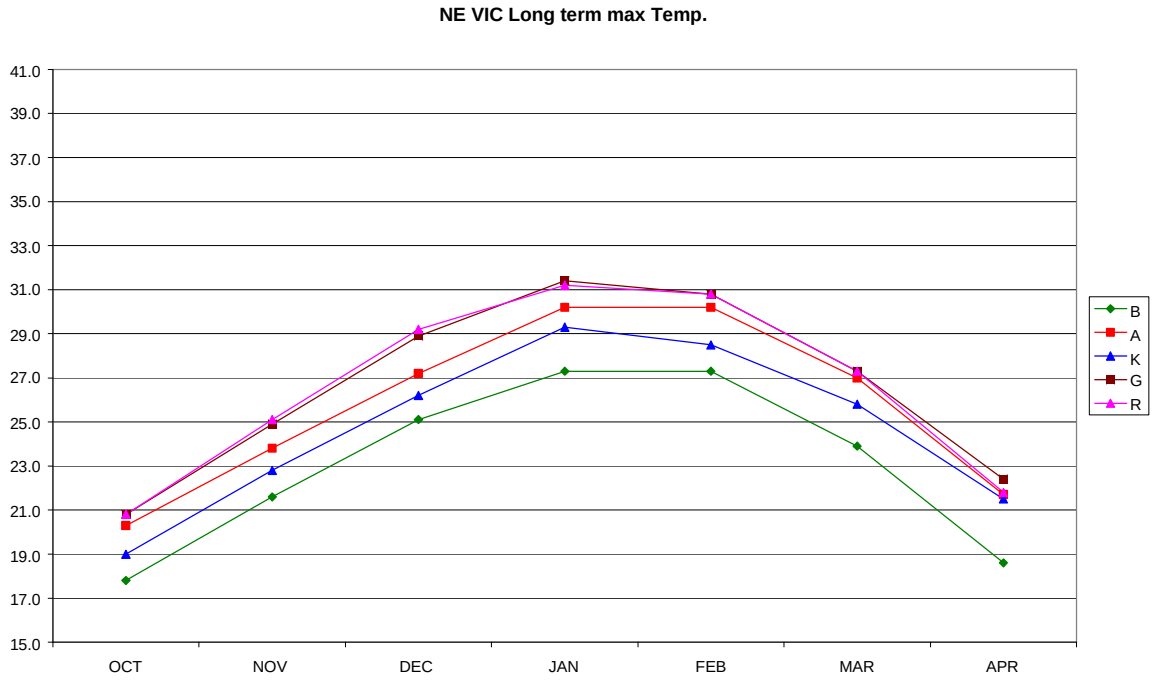


The climate

The region's long-term average maximum and minimum temperatures follow similar annual curves of an inland Australian pattern. Beechworth is generally cooler than the other regions due to its altitude, followed by the mountainous Alpine Valleys.

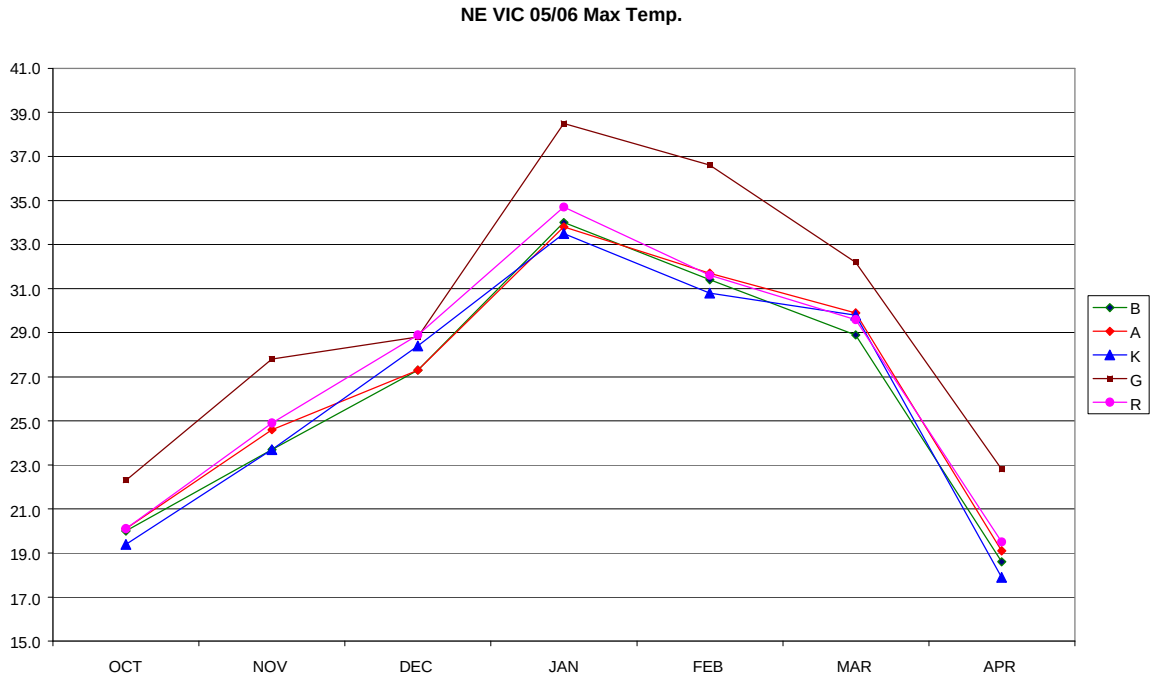
Average Maximum monthly Temperatures

Fig. 2: Average maximum monthly temperatures in the regions, long-term survey.



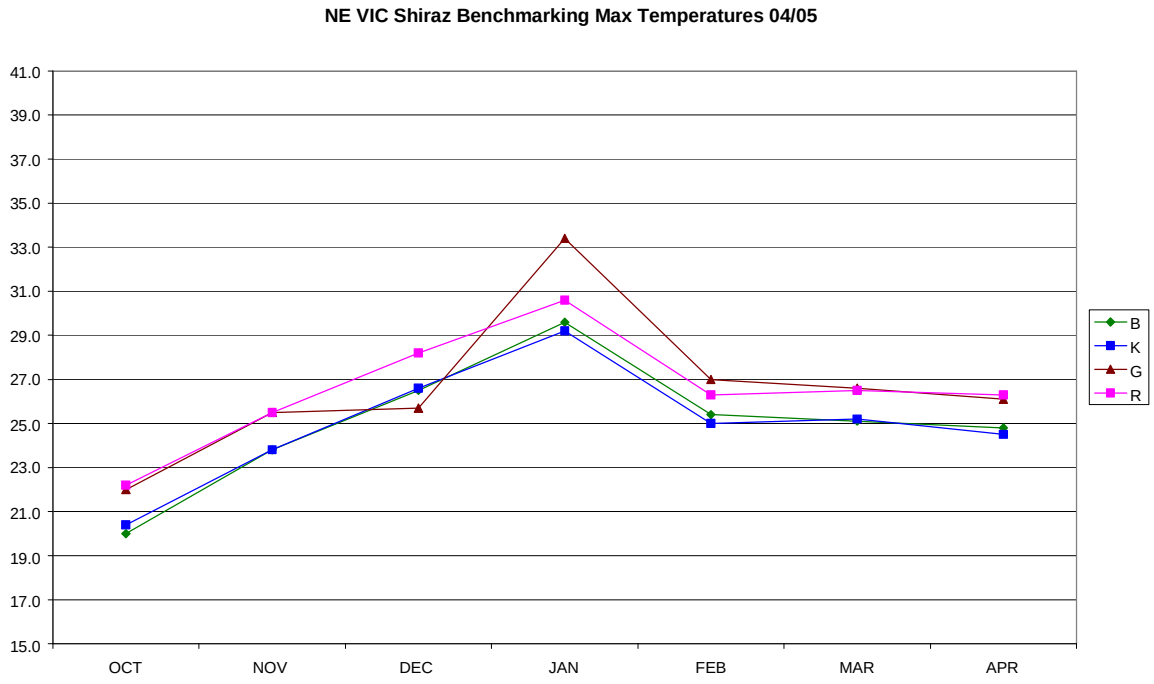
In this season, average monthly **maximum temperatures** of Glenrowan are distinctly higher than those of the other areas (scale of graph extended) this is due to only partial reading having taken place in the latter hotter part of the month of January. Other regions also experienced a warmer than usual summer but little differentiation between the regions (pointing to the influence of the warm air from northern landmass). The end of the season is cooler than average and much cooler than last year and the year before.

Fig. 3a Average monthly maximum temperatures in 05/06



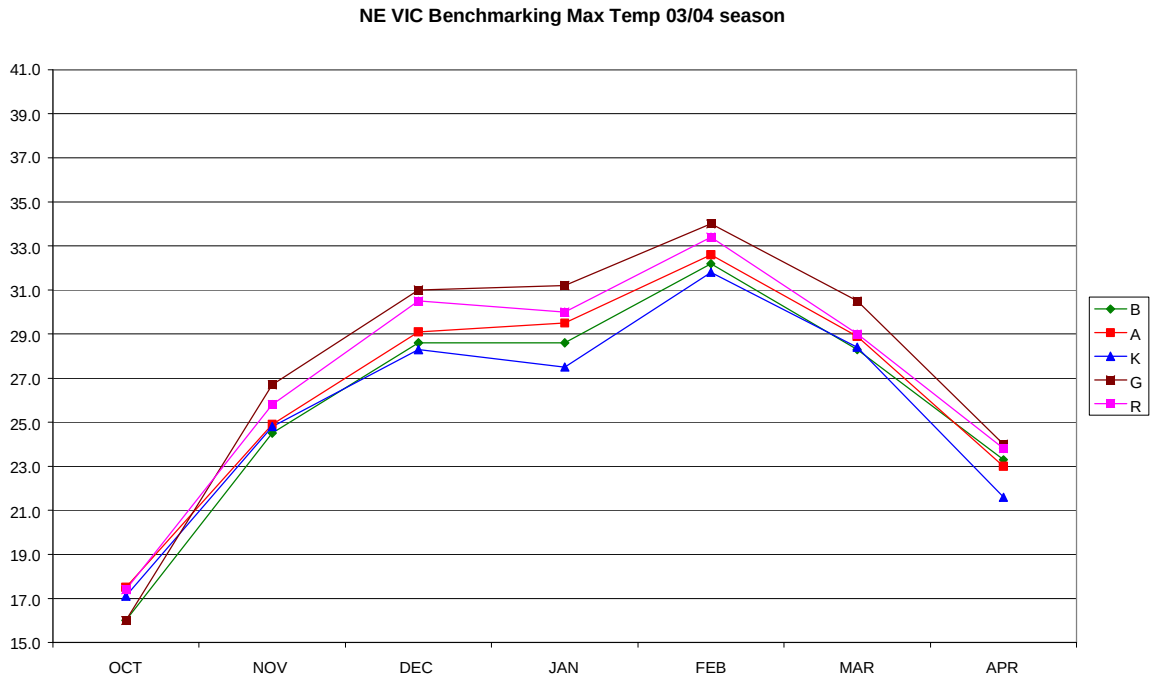
A very warm end to the season was experienced in 04/05

Fig. 3b: Average monthly maximum temperatures 04/05



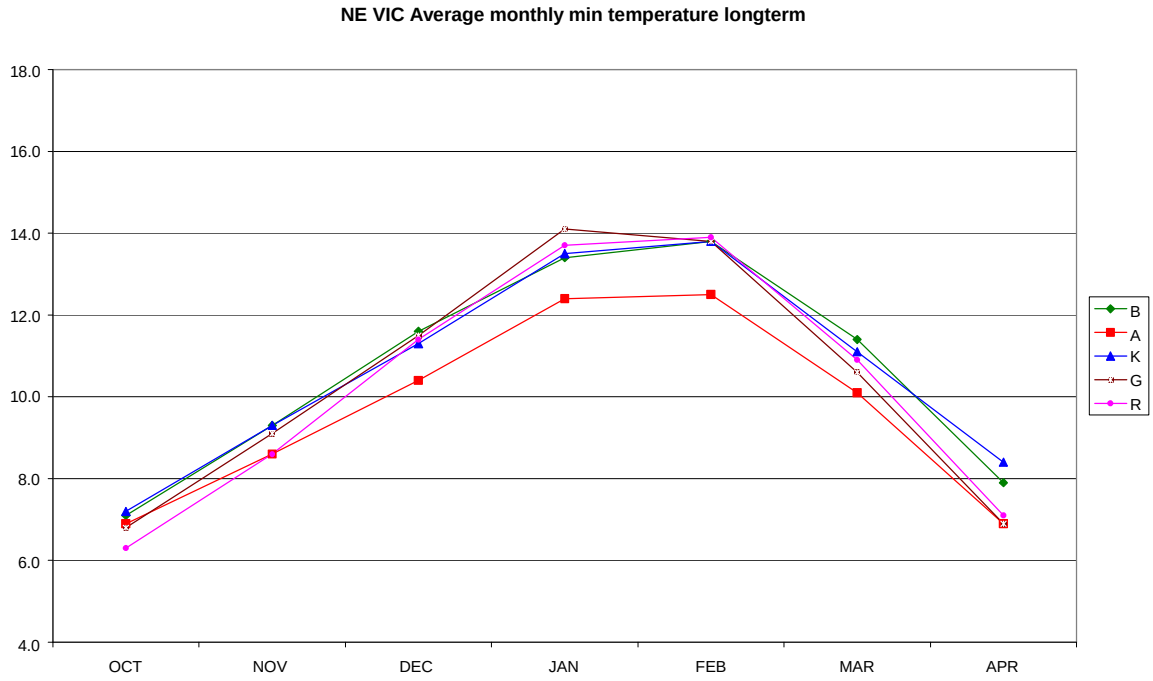
Excessive heat was experienced in the 03/04 season in particular in February which is at the beginning of the main ripening period.

Fig. 3c: Average monthly maximum temperatures 03/04



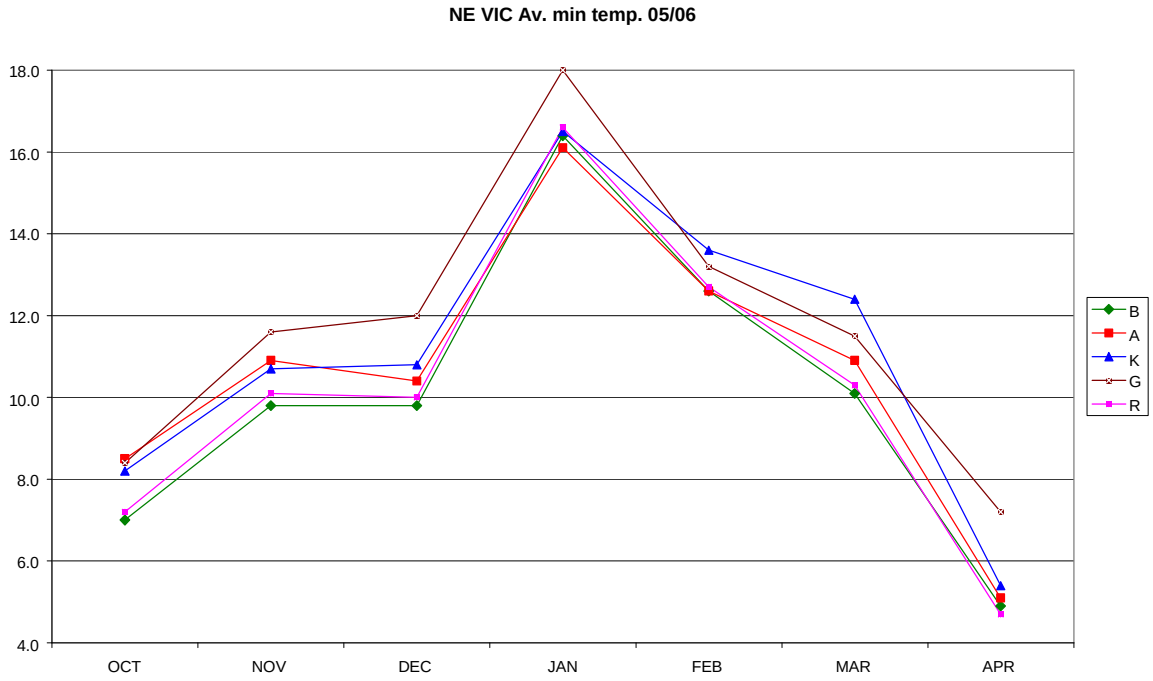
Monthly average minimum temperatures

Fig. 4: Average monthly minimum temperatures in the regions, long-term survey



In this season minimum temperatures were extreme compared with the average with warmer summer nights, a cool early summer and cold autumn nights.

Fig. 5a: Average monthly minimum temperatures in 05/06



The minimum temperatures in 04/05 year were less than average (very cool summer night temperatures for Glenrowan) with a cooler February and March than usual experienced in all regions.

Fig. 5b: Average monthly minimum temperatures 04/05

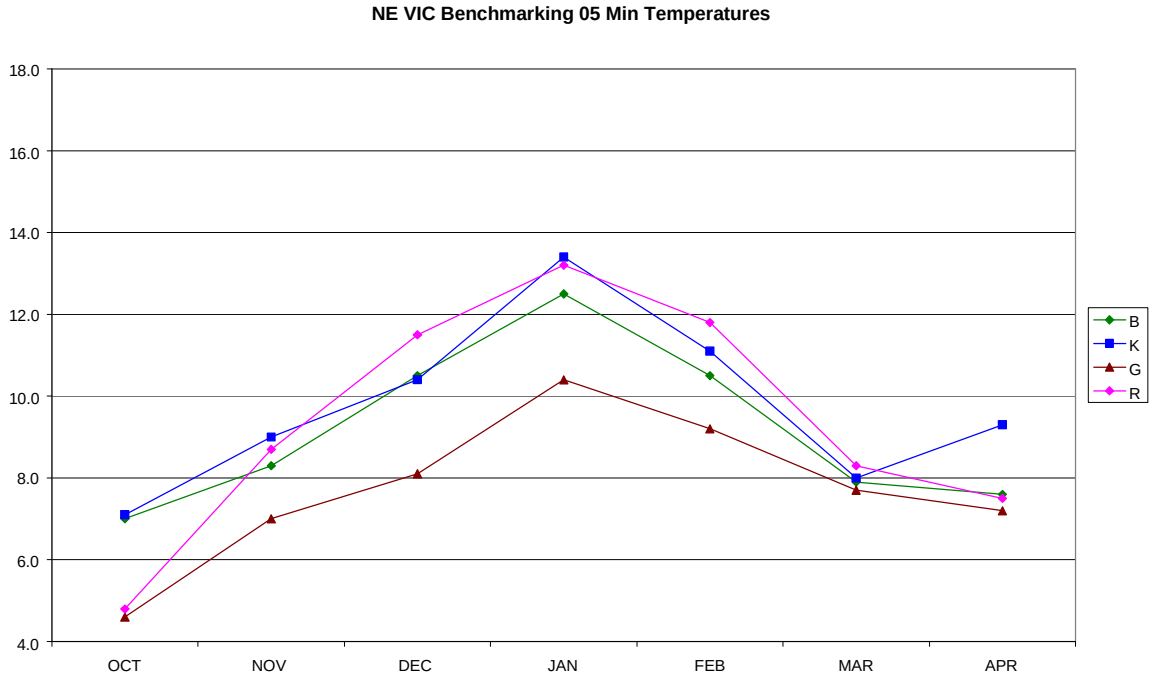
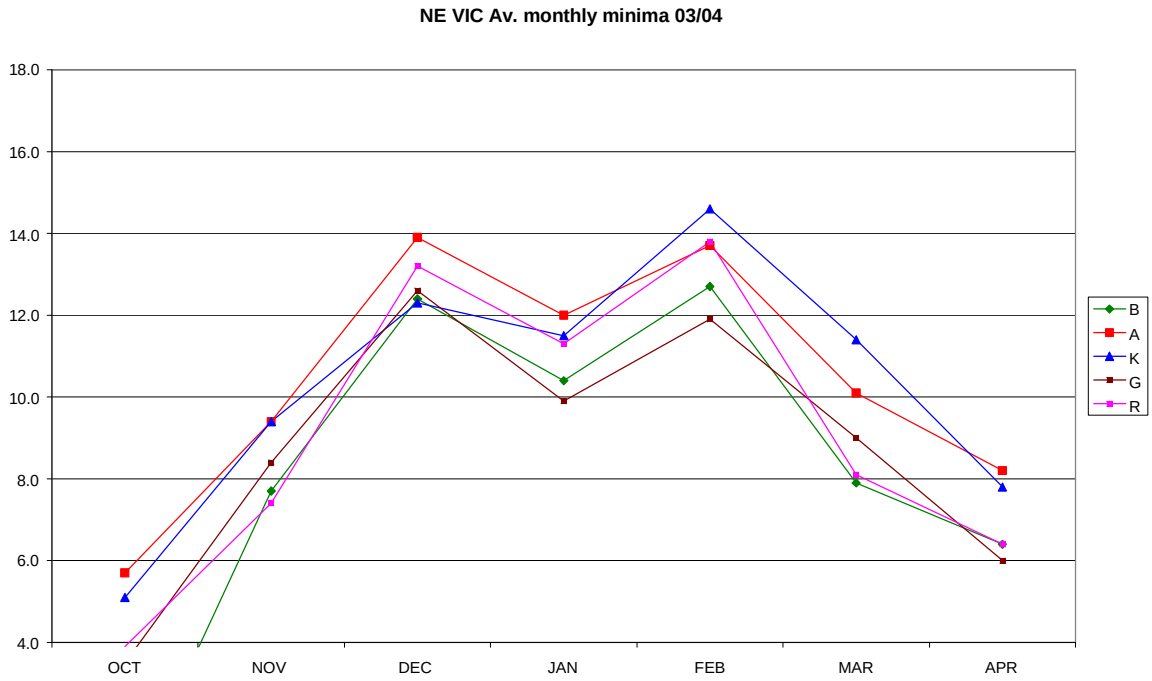


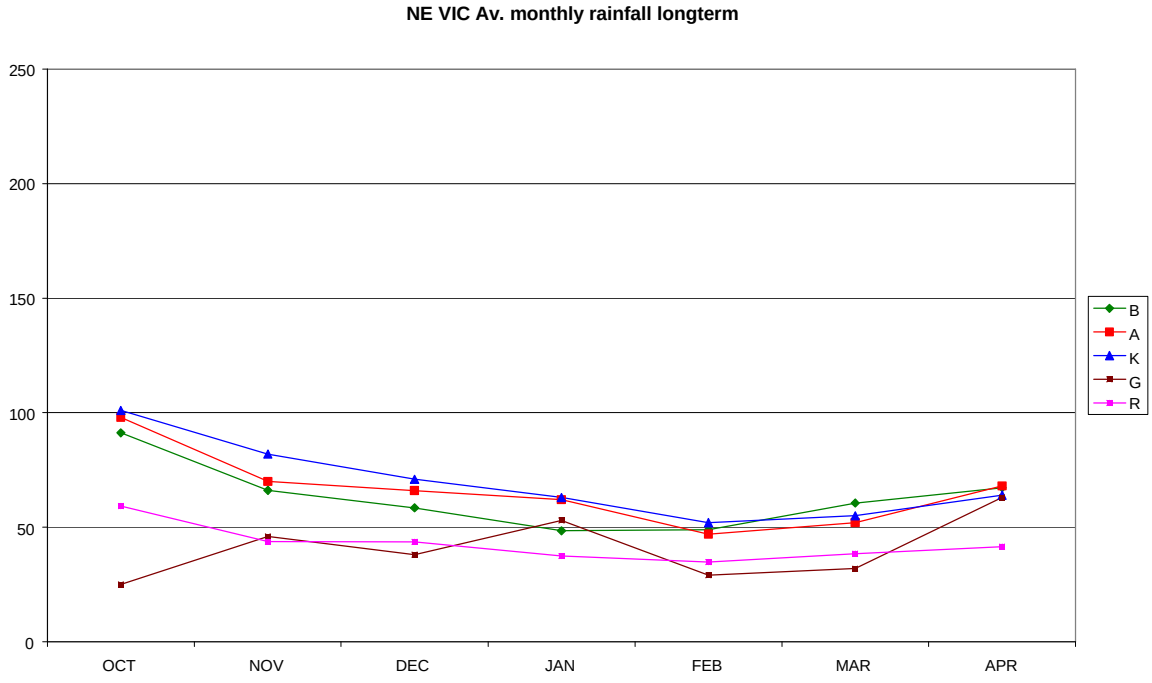
Fig.5c: Average monthly minimum temperatures 03/04



Rainfall

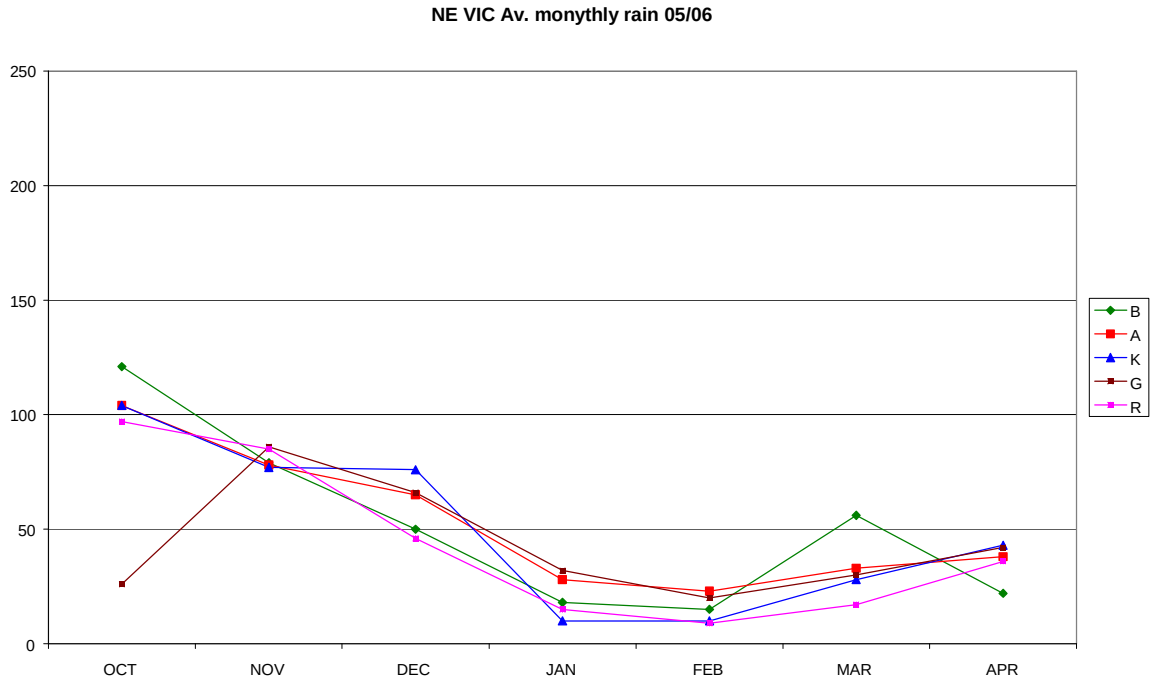
Rainfall is normally much lower further inland (Glenrowan and Rutherglen) than in the mountainous regions. Rain can occur at all times throughout growing season.

Fig. 6: Average monthly rainfall, long-term survey



This season showed a more average pattern compared with the last two and had good rains in spring and pre veraison followed by a very dry spell all summer (except Beechworth in March) (see also Tab. 1 Rain).

Fig. 7a: Monthly Rainfall in 05/06

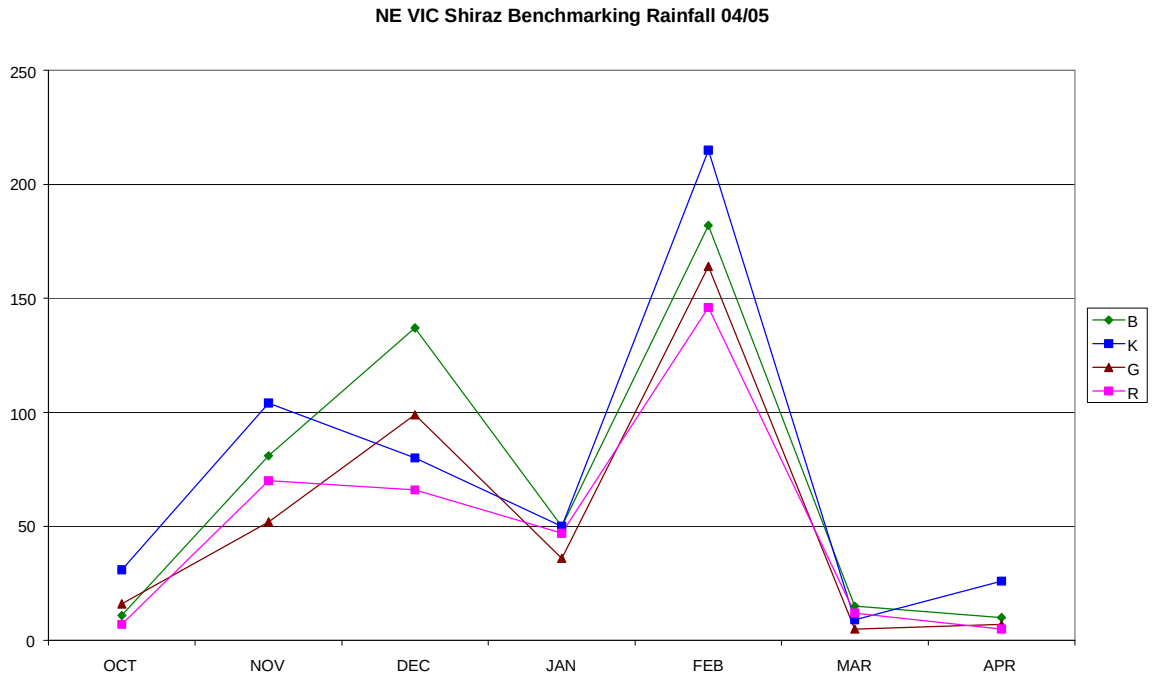


This year some drought effects were visible pre harvest particularly in some rain fed vineyards (due to low dam levels)



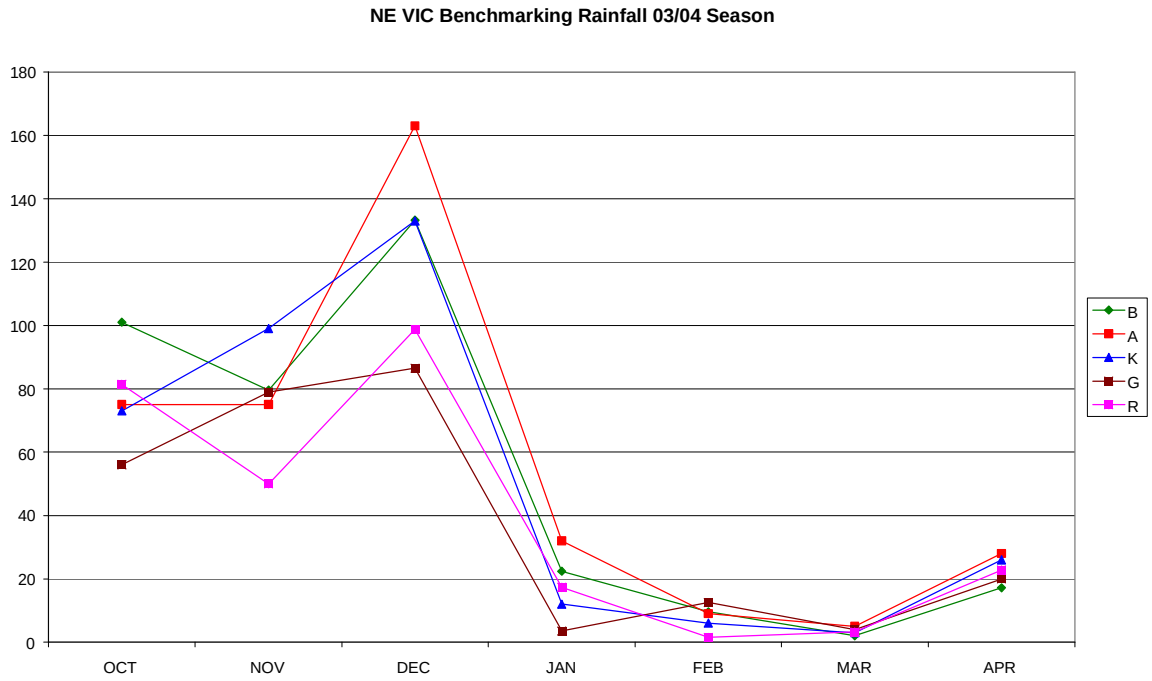
In 04/05 all regions experienced well above average rainfall in December (pre veraison) and particularly in early February (for some vineyards at veraison, for some post veraison) and the growing season finished with a very dry end.

Fig. 7b: Monthly Rainfall in 04/05



Seasonal variations in rain patterns are common for all areas in the region. The year 03/04 had high rainfall in December (after flowering).

Fig. 7c: Monthly Rainfall in 03/04



The vineyards

As can be seen from **Tab. 1** there is quite a variety of locations, plant material (rootstocks, clones) and vineyard management practice (irrigation).

Three vineyards in the mountains were on steep slopes with various aspects. Many vineyards had divided canopies (Scott-Henry or Smart-Dyson due to fertile land but three were vertically shoot positioned and two were sprawling canopies. Row orientation was mostly N/S (10 vineyards) as the valleys run in that direction, NW/SE (6 vineyards), which harvests the morning sun, NE/SW (5), and E/W (4)

Most vineyards were spur pruned, half on them on Schwartzman rootstock and many with the clone pt23.

Three solely rain fed vineyards stood out from the rest in many attributes that have a bearing on root density and water supply. One vineyard was furrow irrigated.

Many vineyards tipped the shoots as required (noted in the scoresheets), some vineyards removed the leaves over the bunch zone or lost basal leaves due to water stress which was noted in the scoresheets under “leaf cover”.

All vineyards deliver grapes to winemakers who decided harvest date and fruit destination.

The vineyard assessment

Was again carried out at 50% veraison (this meant in such diverse regions several trips at different times according to the communication of the vineyard managers when veraison happened)
The active leaf area (cm^2) on bearing shoots was on average the same as in the 04/05 season (see numbers at bottom of graph). The number of active leaves was higher in 06 (in particular those in the small category) than in last year. This could have been due to higher rainfall in early season or management practice.
The number of actively growing tips was minimal due to lack of rainfall in the 4 weeks prior to veraison.

Glenrowan vineyards were again on the less leafy side below 3,000 cm^2 (except 3G and 26G) vineyards with active leaf areas over 4500 cm^2 occurred in all regions. Leaf condition at veraison was on average healthier than last year at both assessment times, despite hotter weather indicating thorough water management.

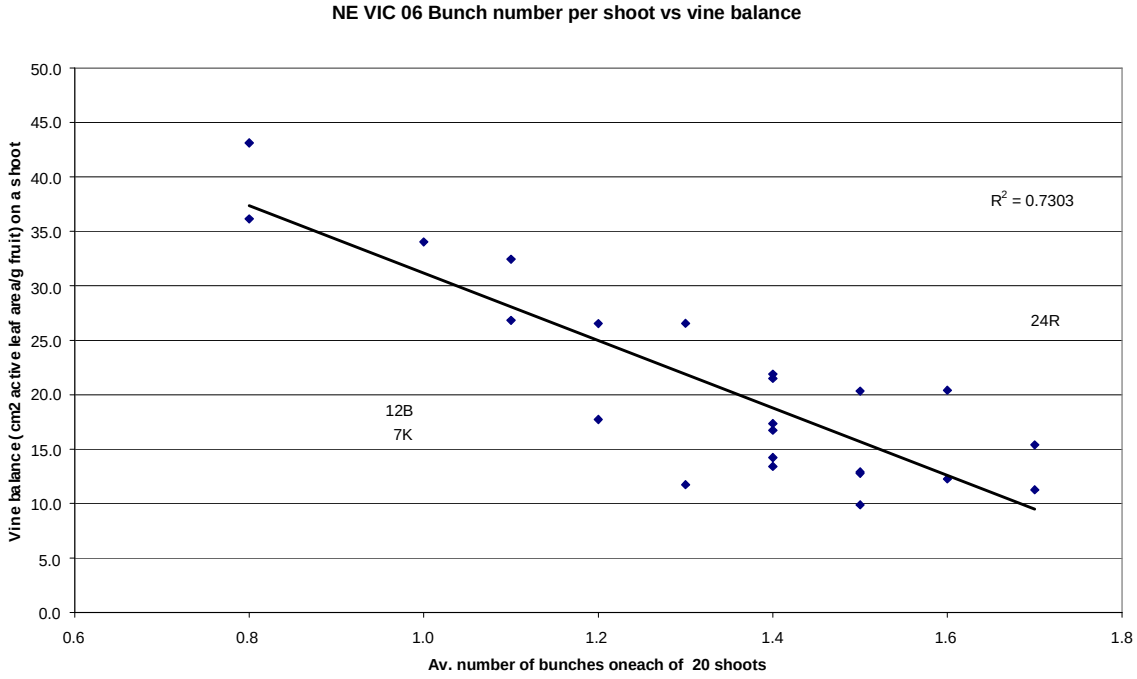
Leaf layers on the “front” were this year lower due to basal leaf loss. This season 9 vineyards had low leaf cover on the east or north side of the rows (compared to 3 last year) most likely in response to the correlations of morning warmth and wine quality seen in last year’s results.

The most striking difference to last year is the lower average number of bunches per shoot (a large percentage of shoots with no fruit) and therewith-higher vine balance (bunch weights on average being the same).

Only vineyards 1A, 4K, 6R, 10A, 15R, 18G 20A and 22G have a vine balance of the recommended 10-15 value.

Vine balance (active leaf area/g fruit weight) depends on leaf size and number as well as on bunch numbers and bunch weights. In the present study a strong dependence on bunch numbers was seen. Exceptions are vineyards 12B and 7K (positions of their points in graph indicated by vineyard code but not statistically included) with a small number of medium sized leaves which dropped the vine balance value, and 24 R (also excluded) where low bunch weights raise the vine balance value without being excessively leafy (see photos).

Fig. 8: Vine balance depended strongly on number of bunches on the shoots.



Thirteen vineyards out of 26 had one or less than one leaf layer on the eastern or southern sides of the bunchzone; this means a considerable change to last year where only 4 out of 25 vineyards had some exposed bunches.

Cane lignification was consistent only in a few vineyards from year to year. Periderm formation was poor when there was water stress (shrivelled berries or rain fed vineyard) or in very leafy canopies as well as under large fruit load per shoot. When these vineyards were excluded from statistics in this year still no significant correlation existed between vine balance (or lack thereof) and cane lignification at veraison.

Fig. 9: Vine balance at veraison did not have a significant influence on cane lignification, but drought stressed vines lignified slower.

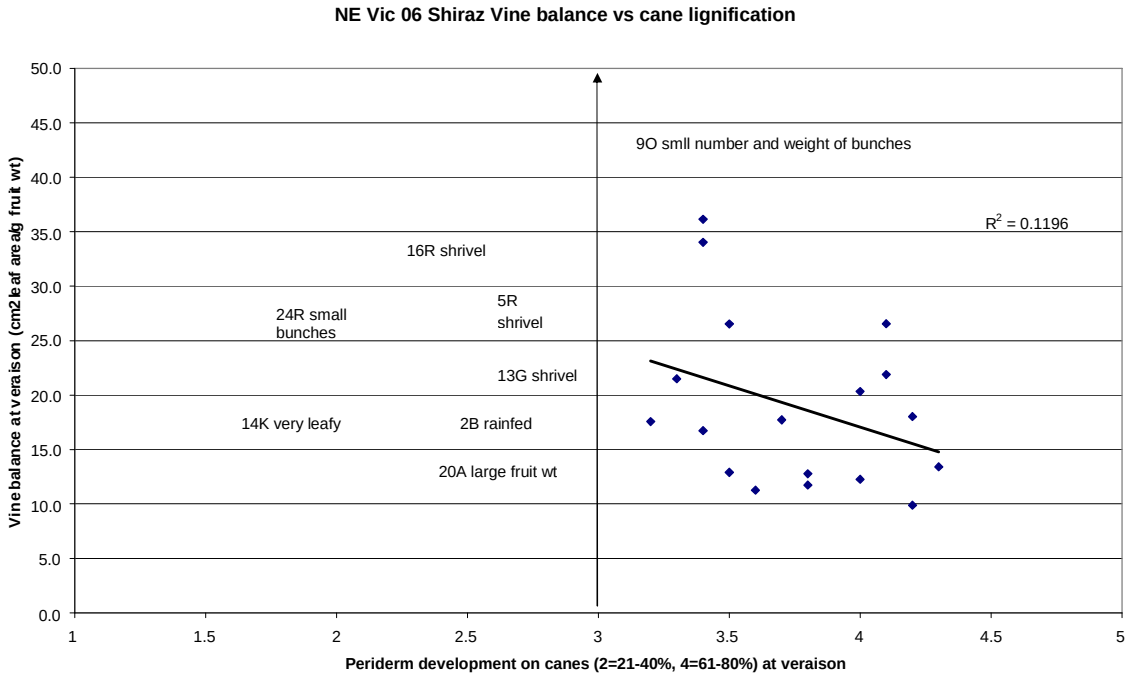
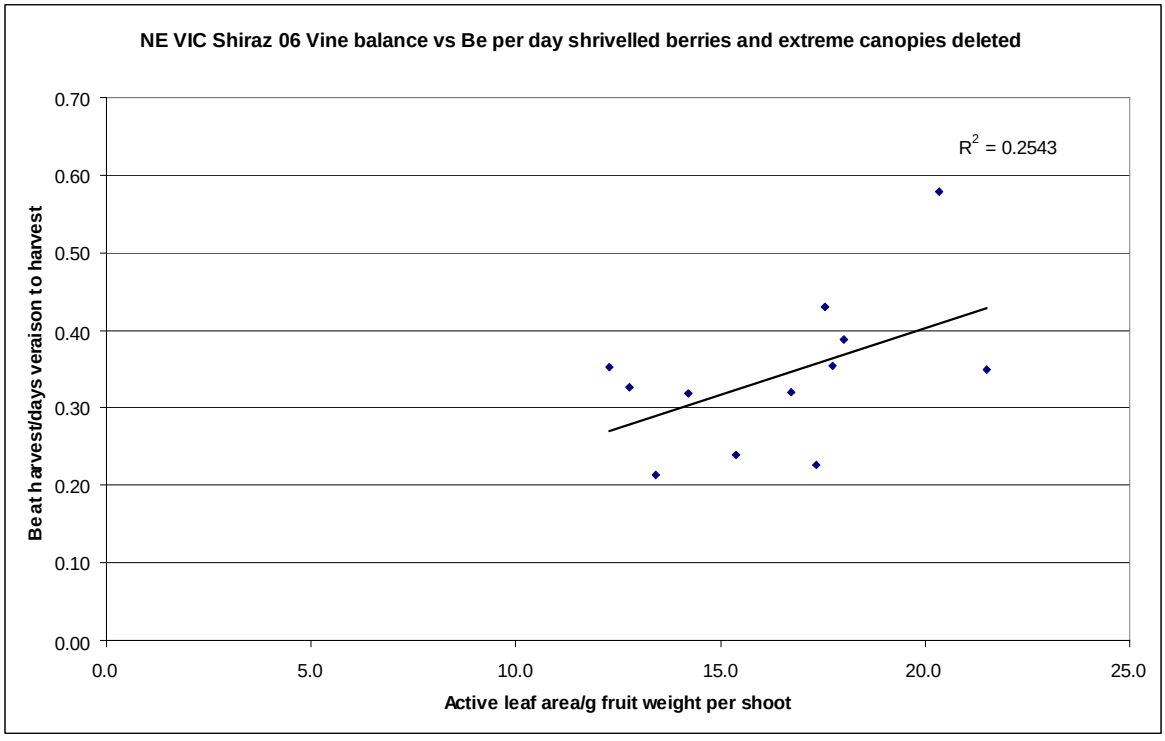


Fig. 10: Like last year, vineyards with a very high leaf area to fruit weight had a faster sugar loading capacity, but sugar loading in the middle vine balance range mainly (when shrivelled berries and extreme canopies were deleted) depended on temperature (see below).



Bunch zone temperatures

Bunchzone temperatures were assessed with the same loggers and calculated in the same way to facilitate comparison between the hotter year 05/06 and the milder year 04/05.
Assessment periods covered the time from veraison to harvest. This period was considerably longer in 05 due to unseasonable rainfall in Feb. (Fig.7b) diluting Brix and slowing ripening. In 2006 some vineyards had very short "hangtimes" (veraison to harvest) due to uninterrupted ripening in beneficial conditions (no cold no rain).

However harvest dates are not necessarily the date of full physiological ripeness – winemakers choose harvest date often as a consequence of technical, logistic, winemaking and other considerations.

A good contrast was provided by comparing 06 with 05 degree hour summations. Some bunch zones accumulated more degree hours either due to heat (18G) or long hangtime (4K) or both (24R), some did not achieve high summations despite long hangtime (2B).

Therefore average degree hours gives a picture of the average "coolness" or "hotness" of the bunches/sites. For most vineyards, this year provided on average warmer bunchzones – due to the mesoclimate and management.

Degree hour summations above 35C showed that in this year there were **real heatloads** on bunches (see Fig. 113).

Degree hours below 15C reveals vineyards with very cold nights but also with canopies that did not allow bunches to warm up early. This can be seen better in the temperature curves (below).

Most vineyards spent about 1,000 degree hours outside of the physiologically important temperature range (15-35C), exceptions are: the cold 4K, or the hot 24R. These comparisons are of interest but it seems that a long duration in the optimum range is not enough, **having little in the extreme range is important too** (see below).

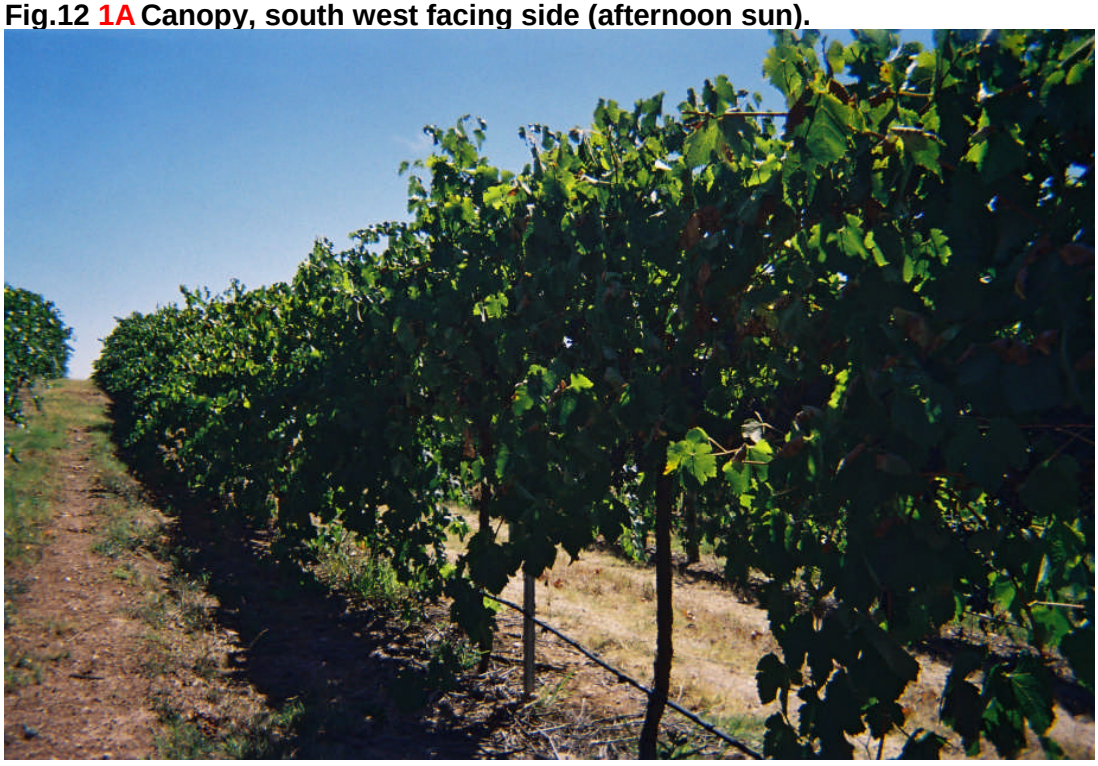
Vineyard visual assessments and bunch zone microclimates

1A On 20% ne slope, nw/se row orientation, VSP trellis

Fig.11: 1A Canopy north east facing side (morning sun).



Fig.12 1A Canopy, south west facing side (afternoon sun).



In this vineyard the bunches heat up quickly (35C at 9 or 10 am) and there is shade at midday from overhead foliage. Heatloads come later in the day due to row orientation and lack of foliage cover and last from 1-4pm (Fig. 16).

Fig. 13: 1A Bunch zone temperatures veraison to harvest - 24,058 degree hours in 40 days.

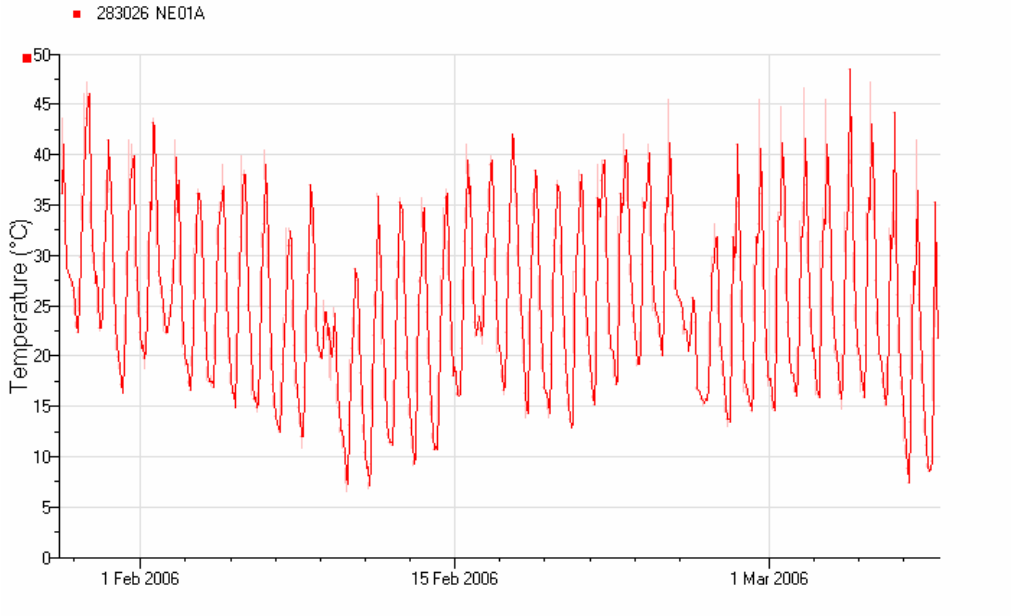


Fig. 14: 1A Bunch zone temperature fluctuation in summer 06

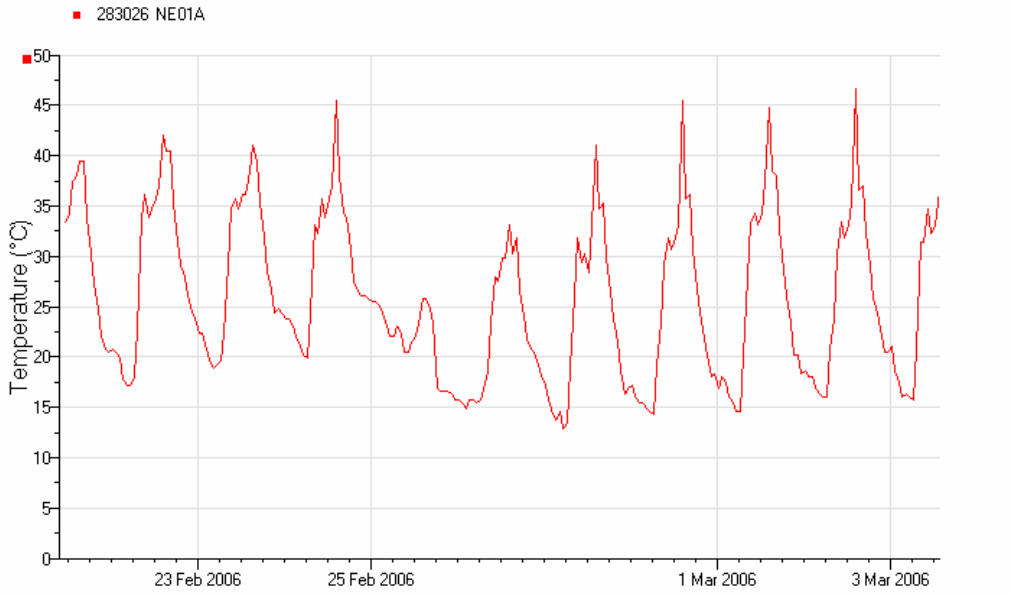
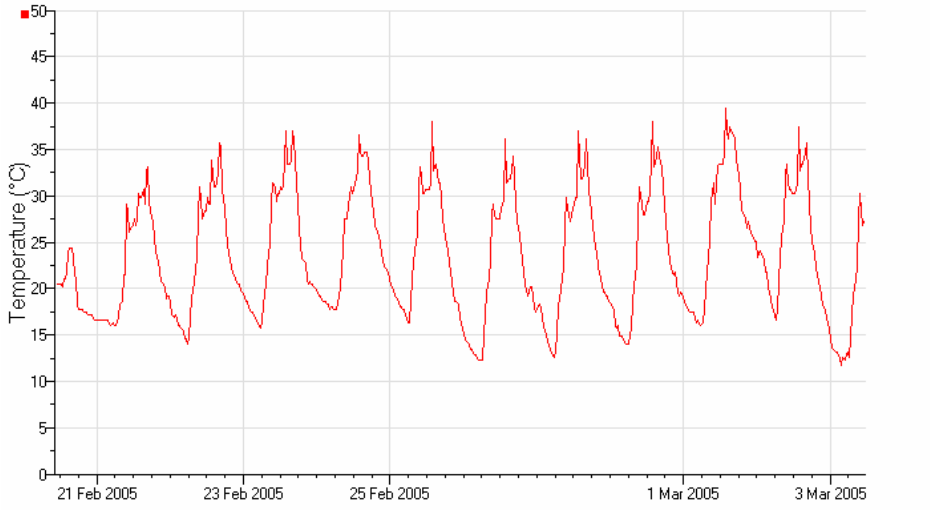


Fig. 15: 1A Bunch zone temperature fluctuation in summer 05

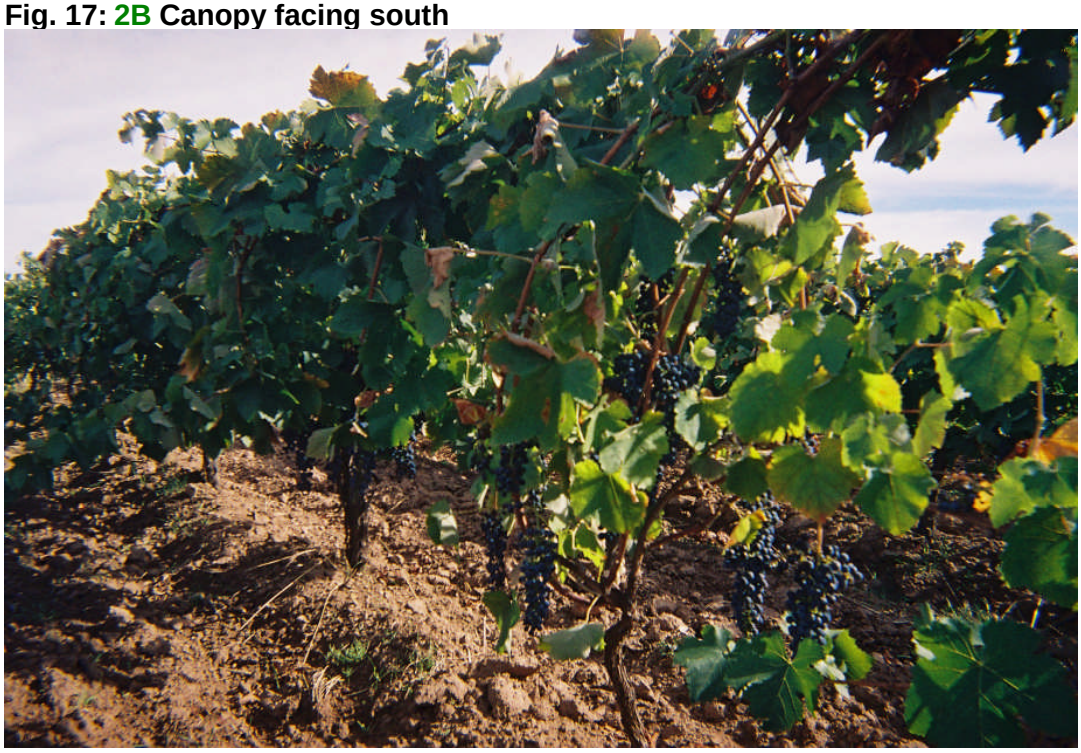


2B On 3% wnw slope, on a plateau, e/w row orientation, smart dyson trellis

Fig. 16: 2B Canopy facing north (photo taken in late morning)



Fig. 17: 2B Canopy facing south



This vineyard was one of the colder ones last year and has improved this year by opening up the canopy to the south. Bunch warmth goes up rapidly and there are low heatloads in the afternoon. Due to location on the plateau only few days of heat, harvest in very cool period.

Fig. 18: B2 Bunch zone temperatures veraison to harvest – 26,260 degree hours in 54 days

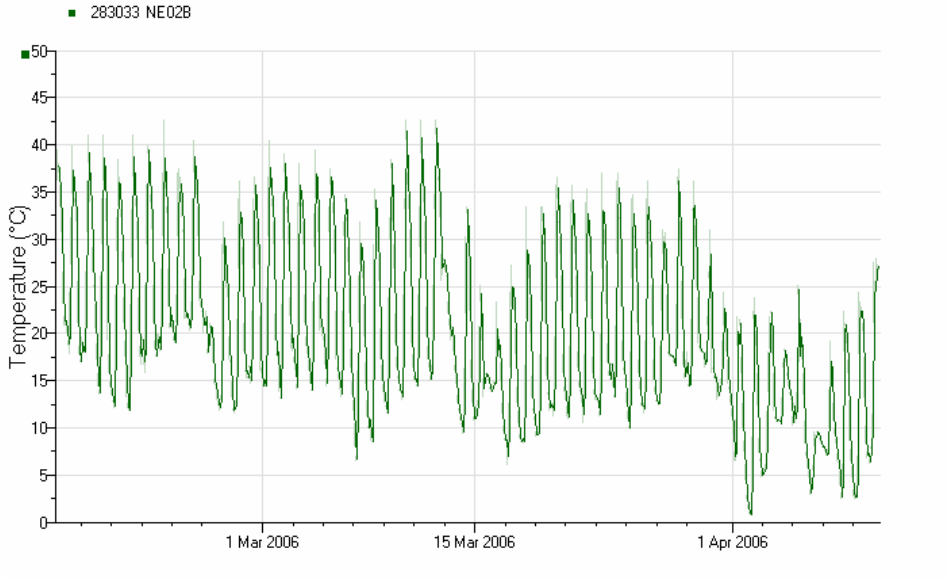


Fig. 19: B2 Bunch zone temperatures in summer 06

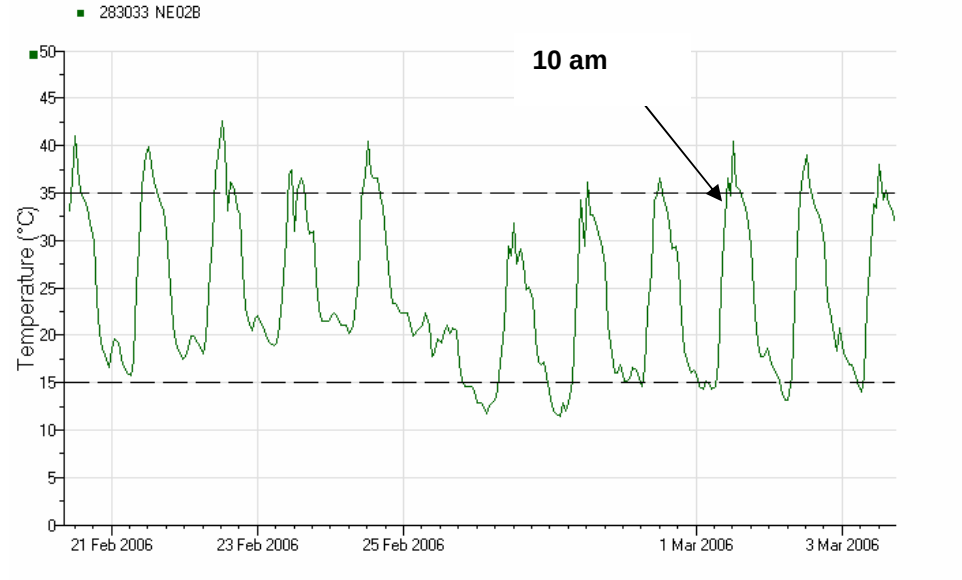
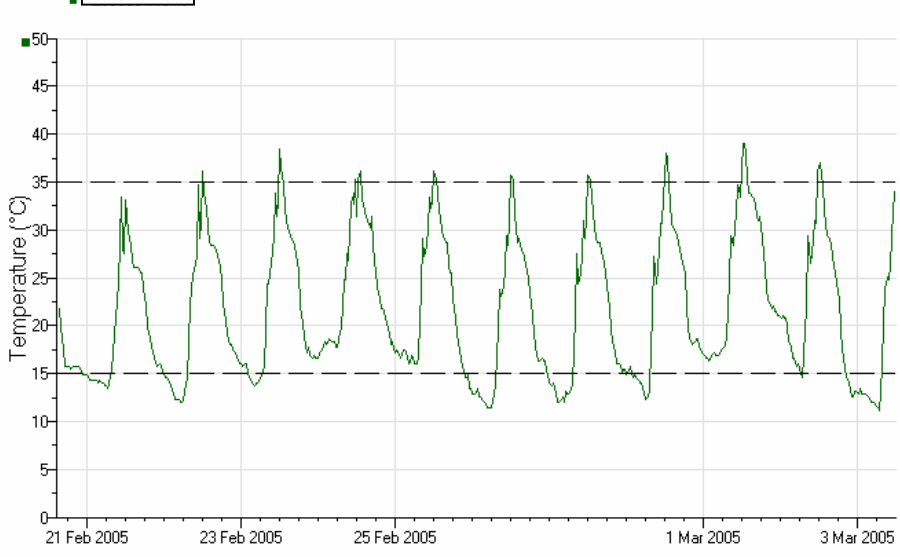


Fig. 20: B2 Bunch zone temperatures summer 05



3G On 10% sw slope, nw/se row orientation, smart dyson trellis, closely hedged.

Fig. 21 3G Canopy facing north-east



Fig. 22 3G Canopy facing south west



Heatloads early season. Sharp rise in morning temperatures due to high exposure to north east, with foliage cover to the south west and thus no heatloads in the afternoons.

Fig. 23: 3G Bunch zone temperatures veraison to harvest -22,596 degree hours in 37 days

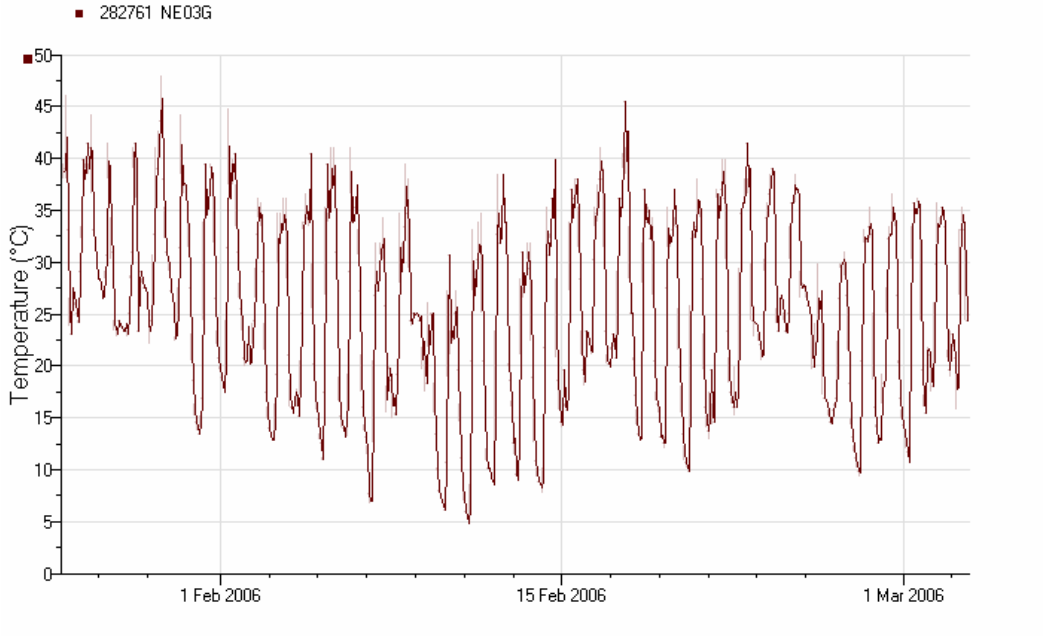


Fig. 24: 3G Bunch zone temperatures in summer 06

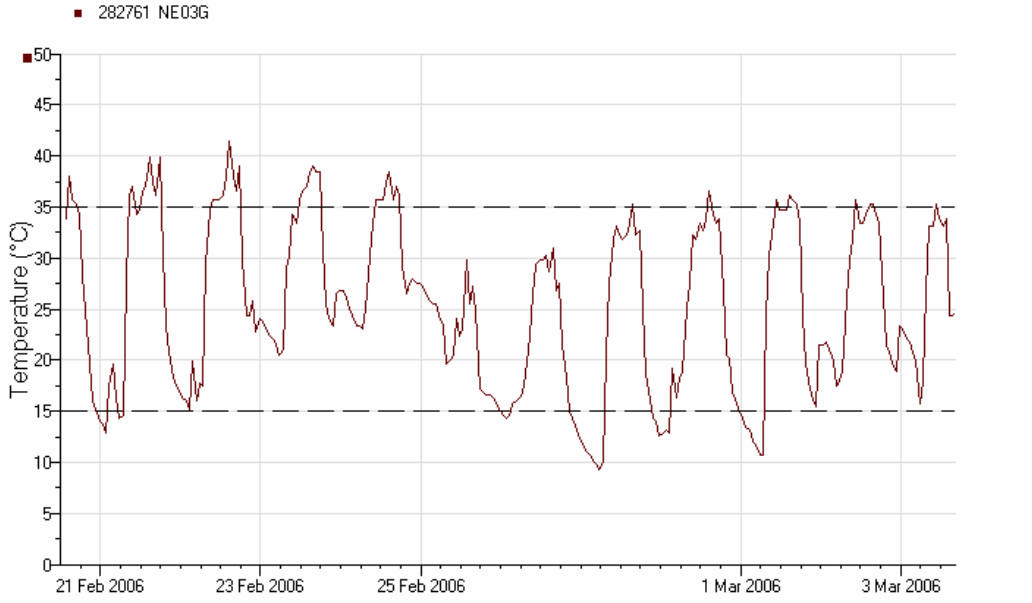
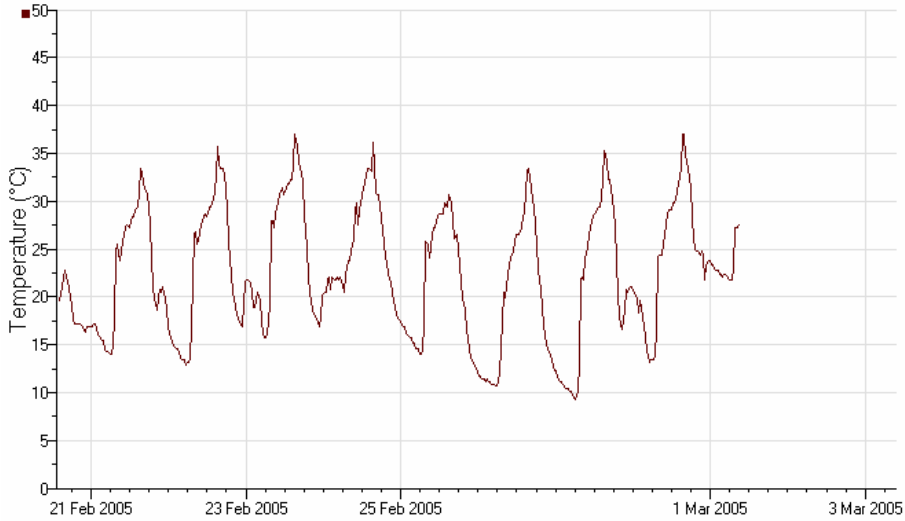


Fig. 25 3G Bunch zone temperatures in summer 05



4KN, On 5% east slope, n/s row orientation, Smart Dyson trellis, in a depression with cold air flow

Fig. 26: 4KN Canopy facing east



Fig. 27: 4KN Canopy facing west



Between 8am and 12 noon (arrows) slow rise of bunch warmth due to foliage cover (1.8 layers) in east, then heat loads due to lack of foliage (0.7 layers) in west .

Fig. 28 4KN Bunch zone temperatures veraison to harvest - 29964 degree days in 67 days

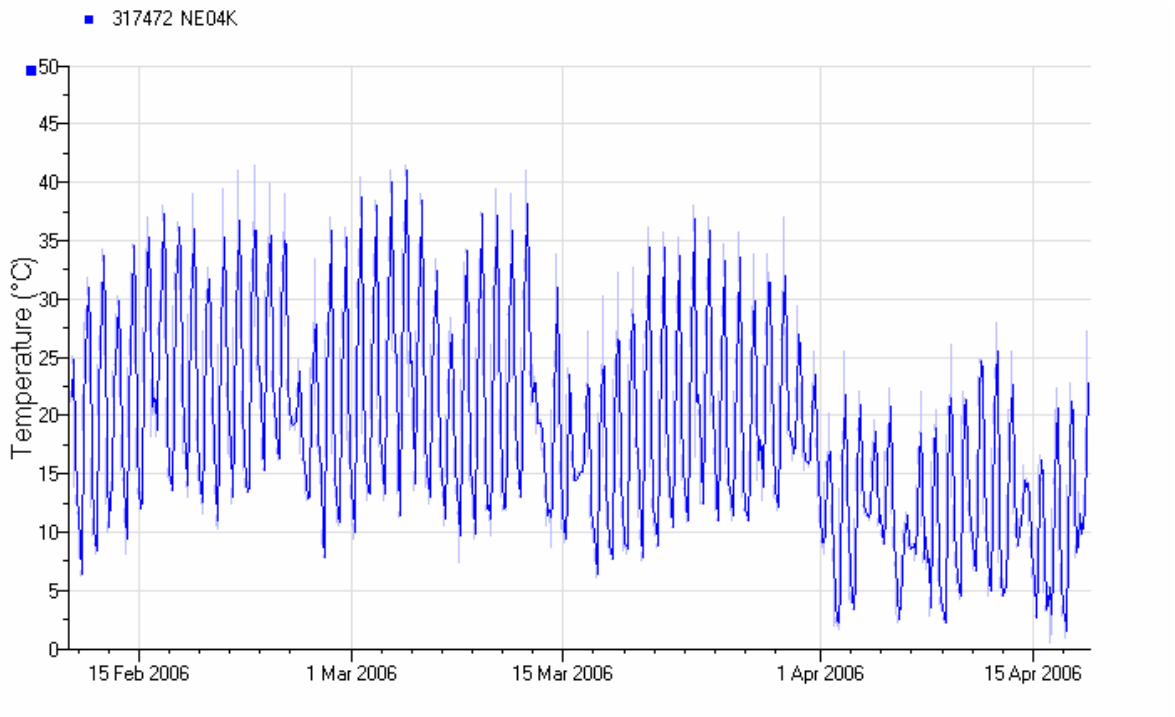
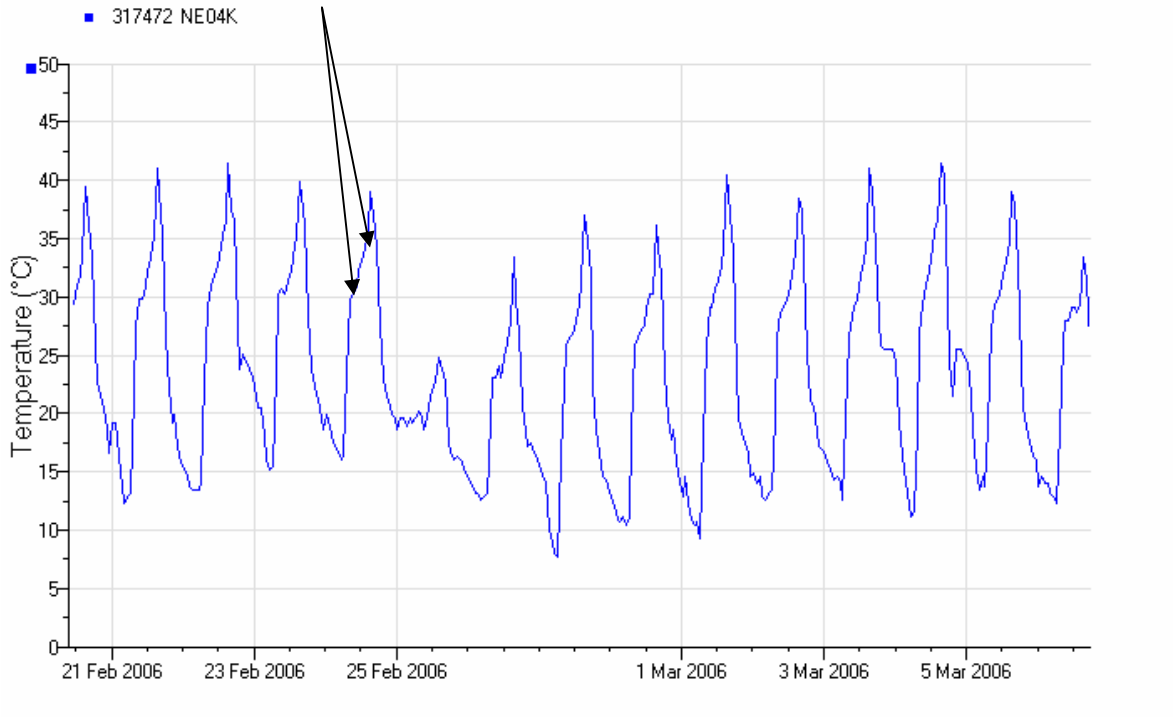


Fig. 29 4KN Bunch zone temperatures in summer 06



5 R On 10% sw slope, ne/sw row orientation, sprawling canopy no foliage wires, bunchzone higher in the canopy compared to a vertical trellis.

Fig. 30: 5 R Canopy facing south east



Fig. 31: 5R Canopy facing north west



Sharp rise in bunch temperatures like last year but avoiding extreme heat loads between 11am and 3pm (arrows Fig. 30).

Fig. 32: 5R Bunch zone temperatures veraison to harvest - 23,831 degree hours in 42 days

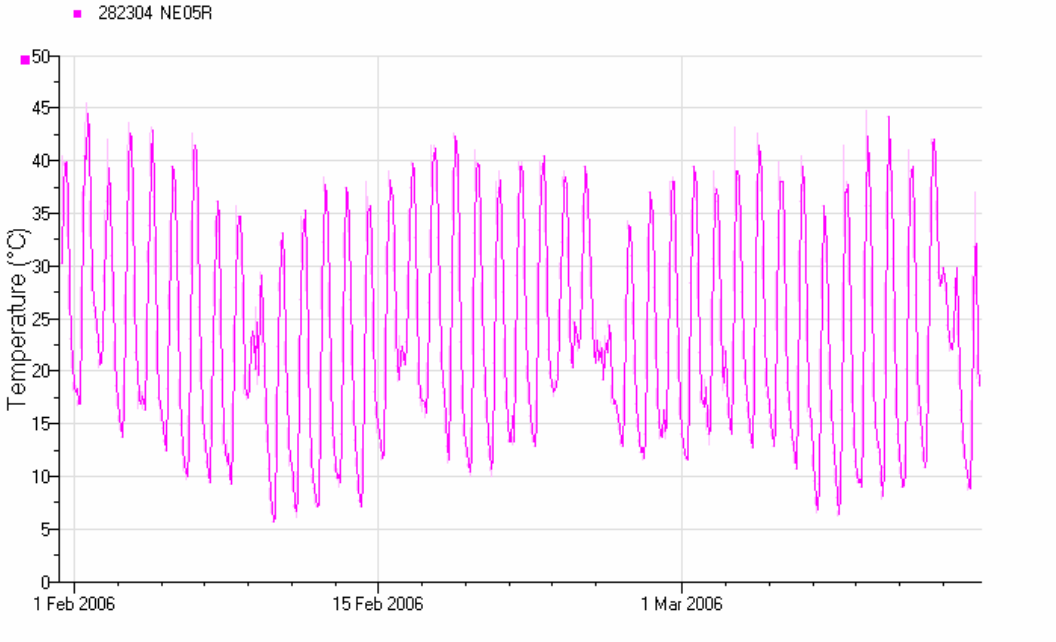


Fig. 33: 5R Bunch zone temperatures in summer 06

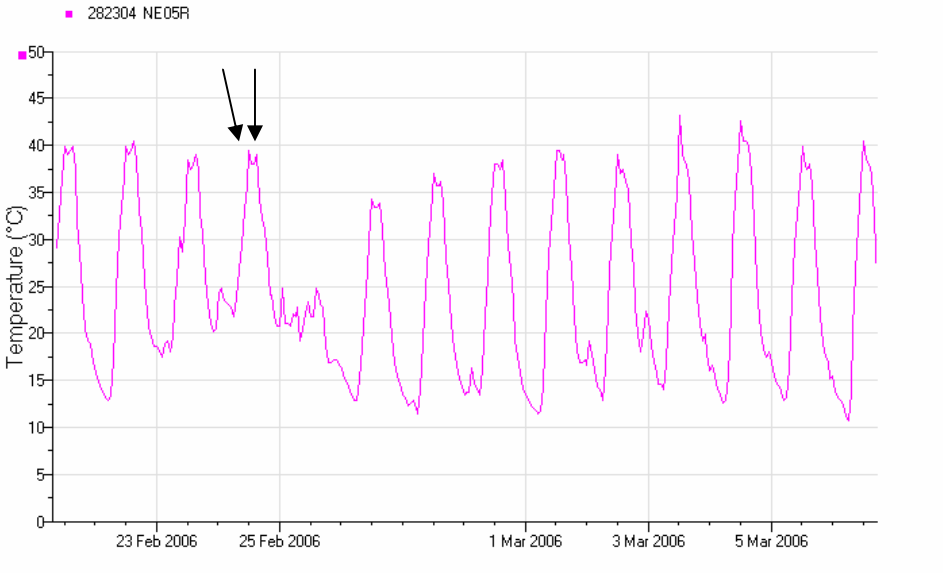
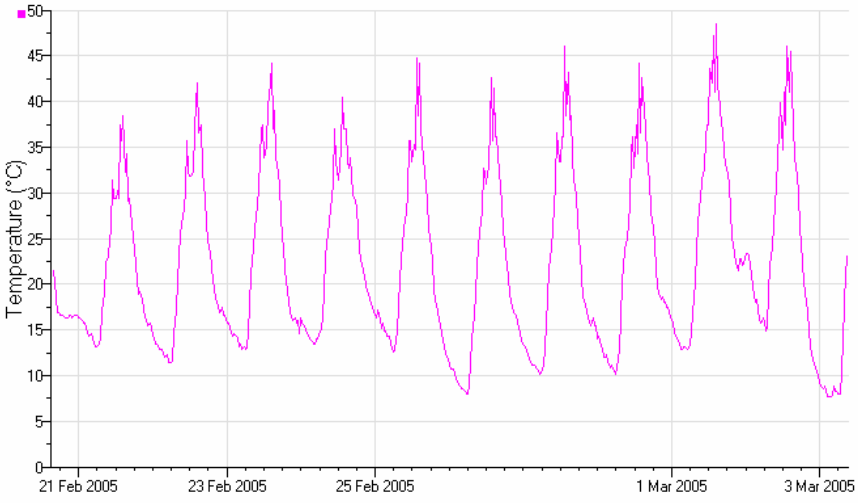


Fig. 34: 5R Bunch zone temperatures in summer 05



6R On 10% wnw slope, nw/se row orientation, smart dyson trellis

No Bunch Temperature data available due to datalogger defect.

Fig. 35: 6R Canopy facing north east (morning)

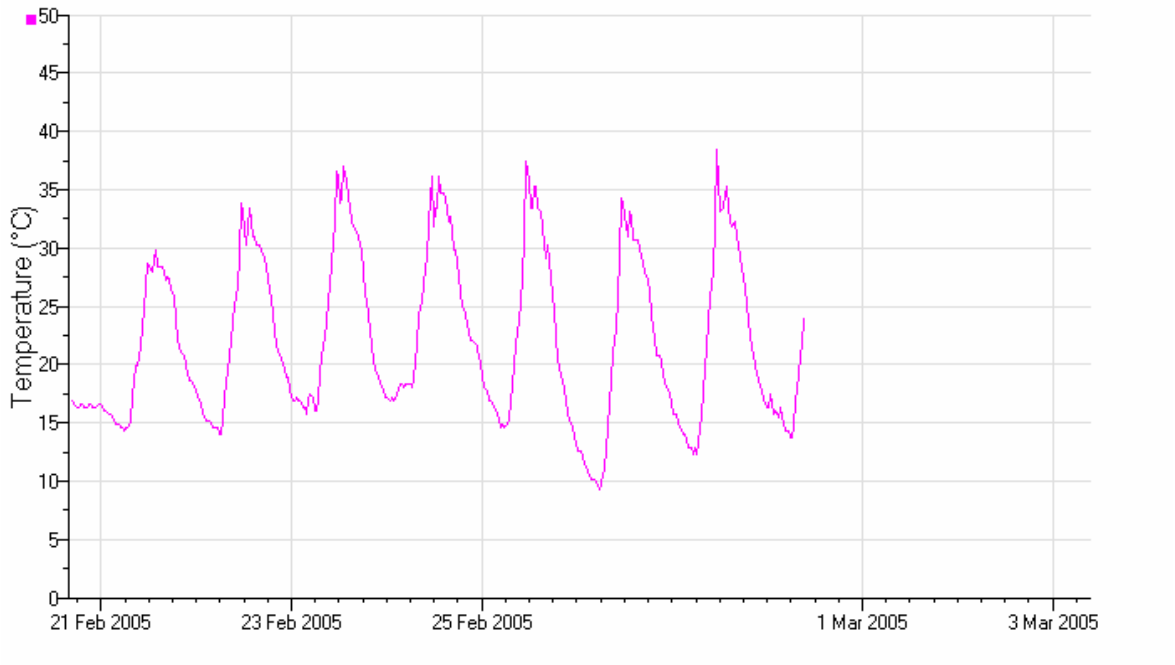


Fig. 36: 6R Canopy facing south west



High amount of leaf cover of particular disadvantage to the morning sun side.

Fig. 37: 6R Bunchzone temperatures in 05



7K On 5% wsw slope, n/s row orientation, smart dyson trellis, basal leaf loss and dead leaves in fruitzone.

Fig. 38: 7K Canopy facing east



Fig. 39: 7k Canopy facing west



This year ripened faster and warmer, without too many heatloads but warmer nights. Overhead protection from foliage early mid day (dent in curve Fig. 35) short afternoon heat. Light crop.

Fig. 40: 7K Bunch zone temperatures veraison to harvest - 21,114 degree hours in 34 days

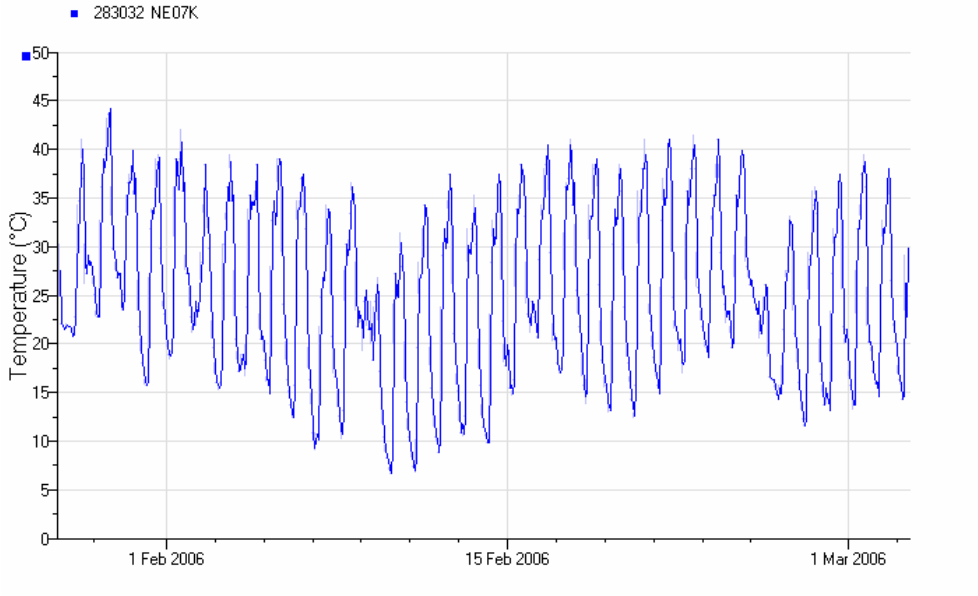


Fig. 41: 7K Bunch zone temperatures in summer 06

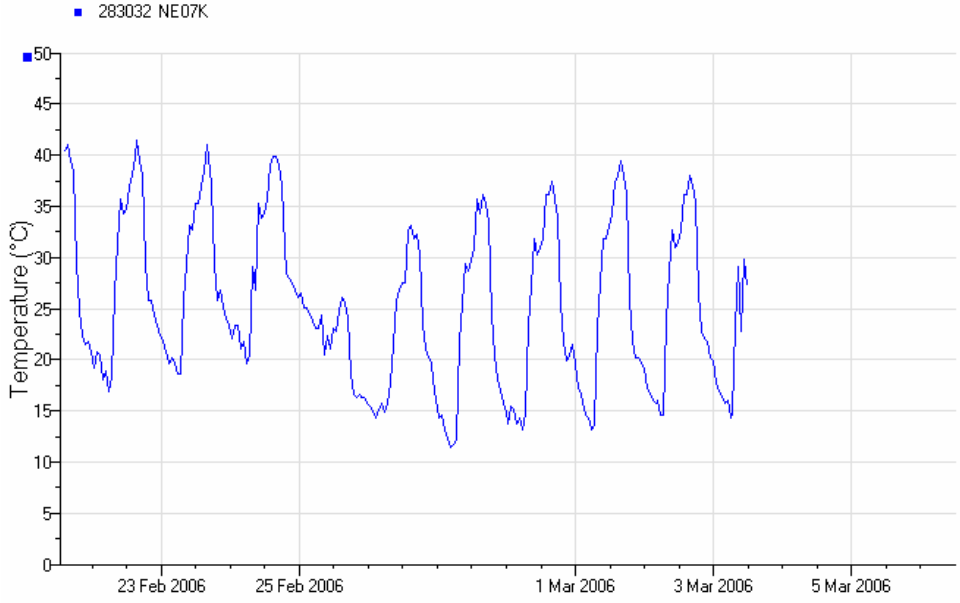
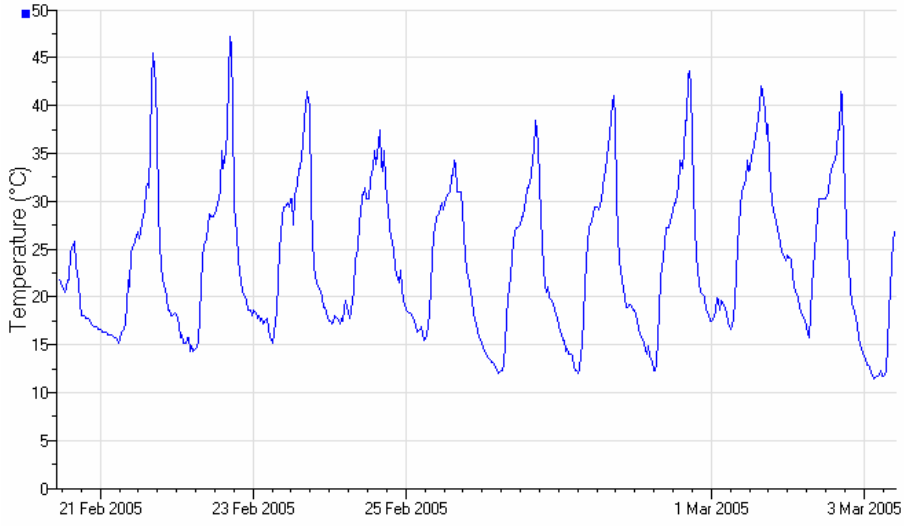


Fig. 42: 7K Bunch zone temperatures in summer 05



8O On flat terrain, n/s row orientation, smart dyson trellis

Fig. 43: 8O Canopy facing east



Fig. 44: 8O Canopy facing west



This year fast ripening, higher heat loads than last year, warmer nights. Fast rise in bunch temperature to 10am (first arrow) with leaf cover late morning reaching 35C at 2pm, peak heat at 4pm with sharp decline (Fig. 39).

Fig. 45: 8O Bunch zone temperatures veraison to harvest - 21,080 degree hours in 36 days

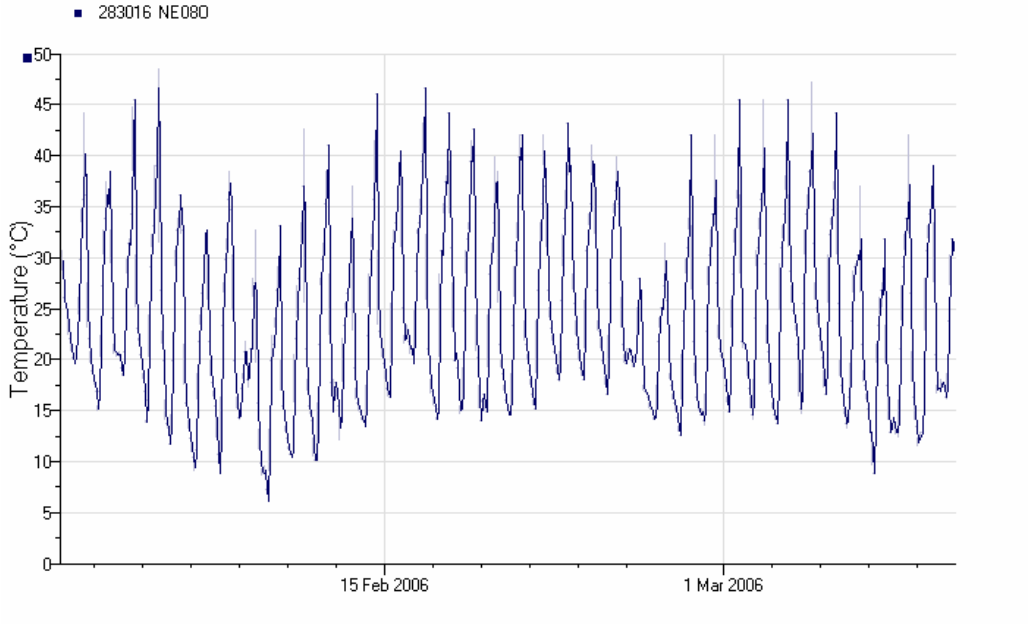


Fig. 46: 8O Bunch zone temperatures in summer 06

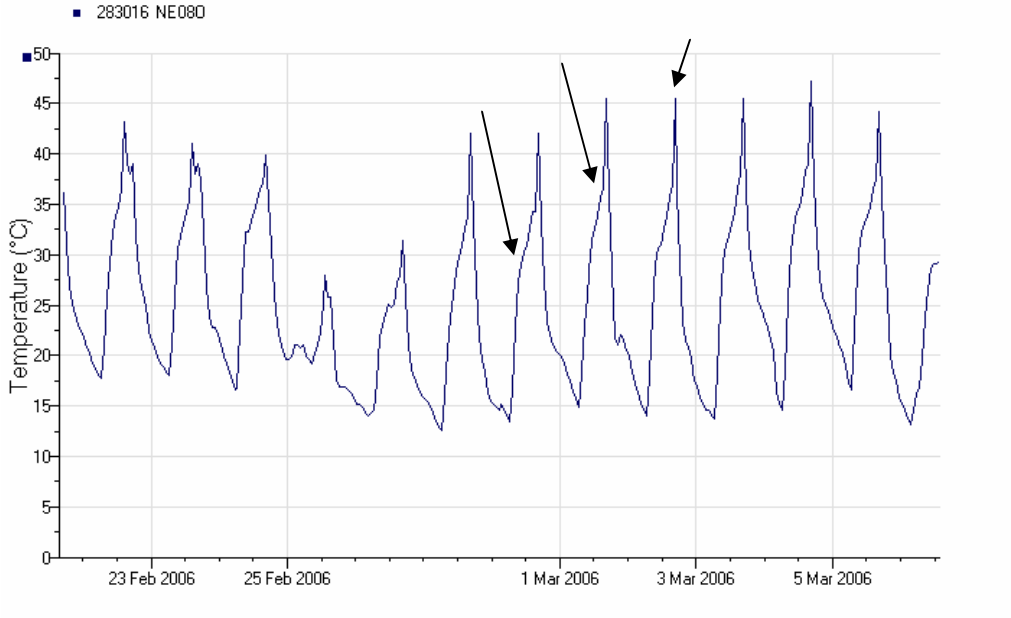
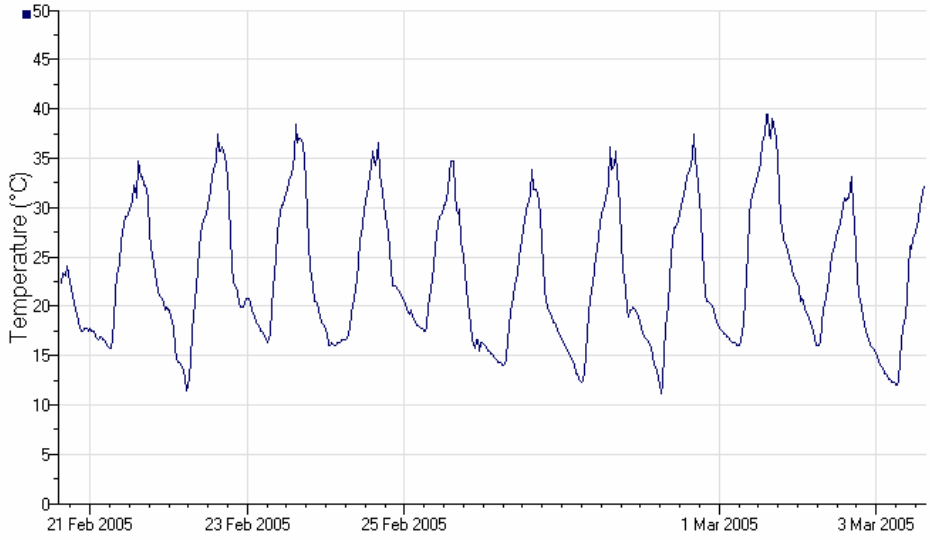


Fig. 47: 8O Bunch zone temperatures in summer 05



9O On 15% wnw slope, n/s row orientation, smart dyson trellis

Fig. 48: 9O Canopy facing east, drought stressed leaves



Fig. 49: 9O Canopy facing west



Fast ripening this year, which shortened the number of hot days. Bunch warmth in the morning. Low shoot vigour site. Heatloads in the afternoon due to basal leaf loss.

Fig. 50: 9O Bunch zone temperatures veraison to harvest - 26,107 degree hours in 41 days

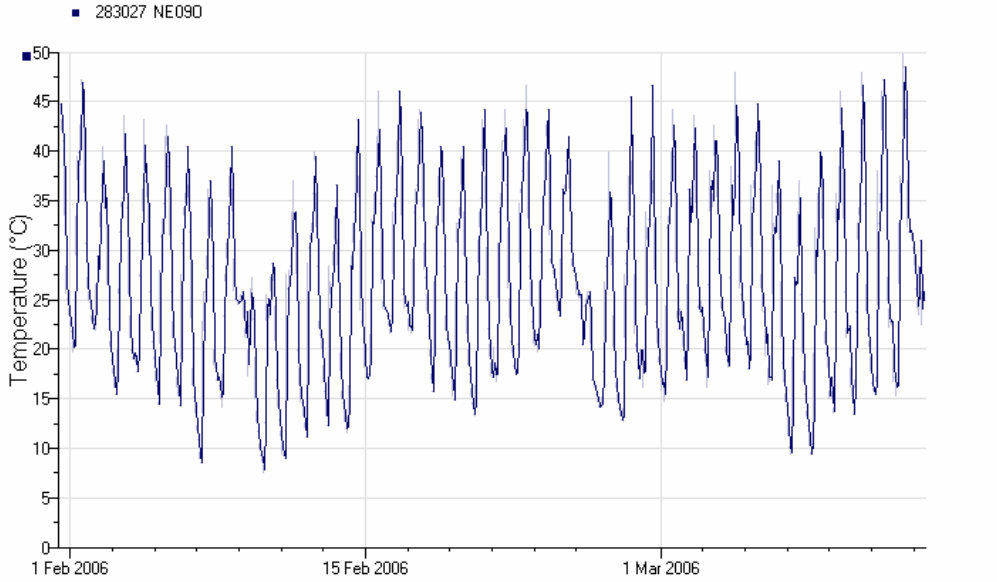


Fig. 51: 9O Bunch zone temperatures in summer 06

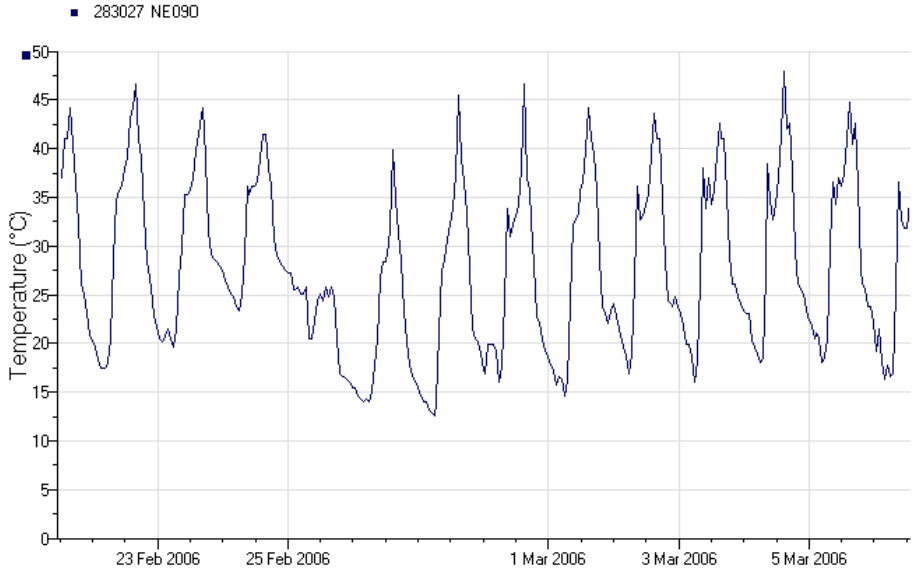
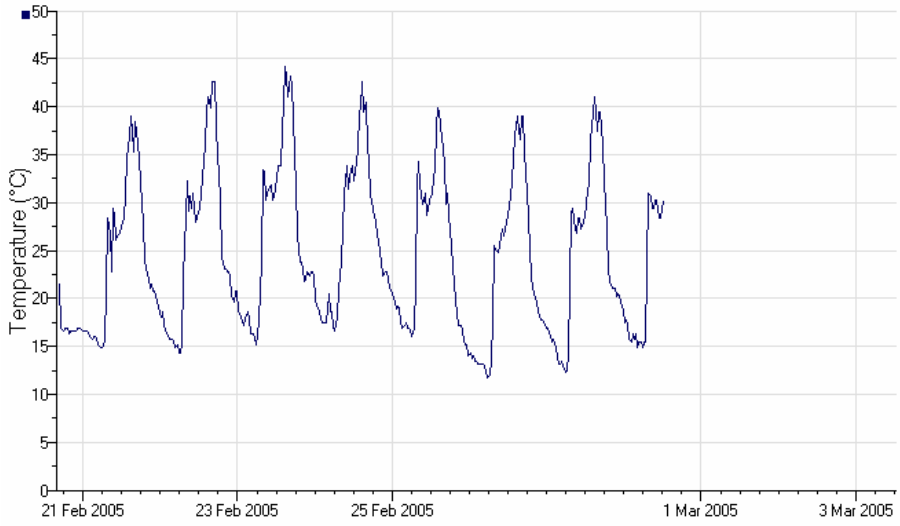


Fig. 52: 9O Bunch zone temperatures in summer 05



10A On 10% nw slope, ne/sw row orientation, smart dyson trellis, bunch thinned.

Fig. 53: 10A Canopy facing south east



Fig. 54: 10A Canopy facing north west



Leaf plucking on SE side. High bunch exposure and morning heatloads. Overhead foliage shade at midday with some heat in the afternoon. Faster ripening this season resulting in a relatively low heat summation despite warmer nights.

Fig. 55: 10A Bunchzone temperatures veraison to harvest - 17,692 degree hours in 31 days

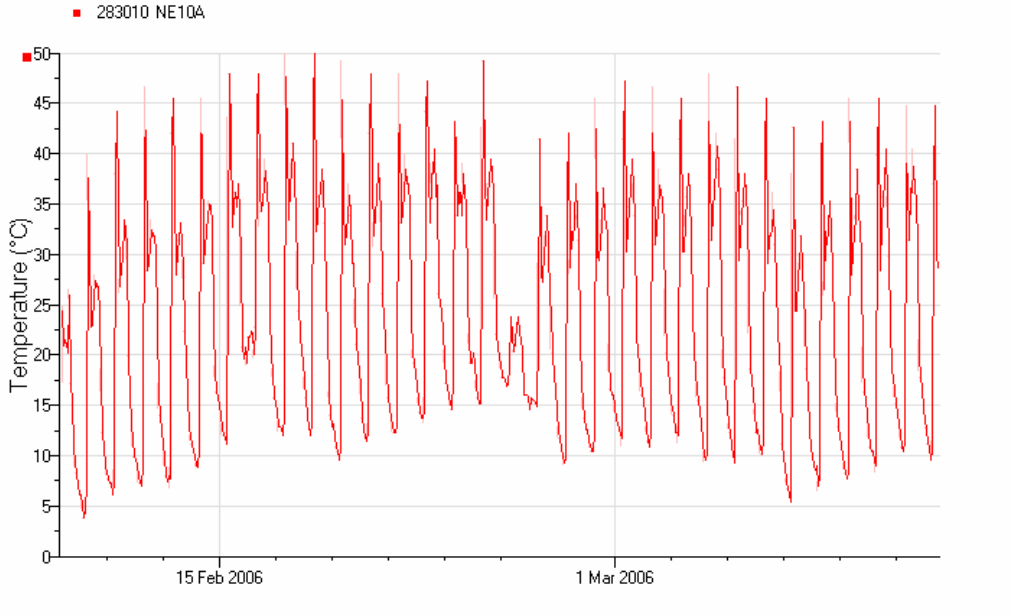


Fig. 56: 10A Bunchzone temperatures summer 06

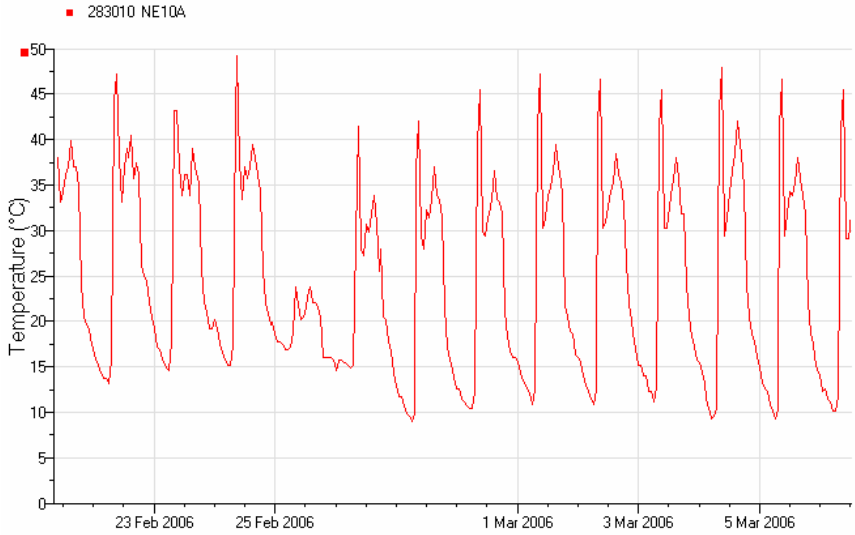
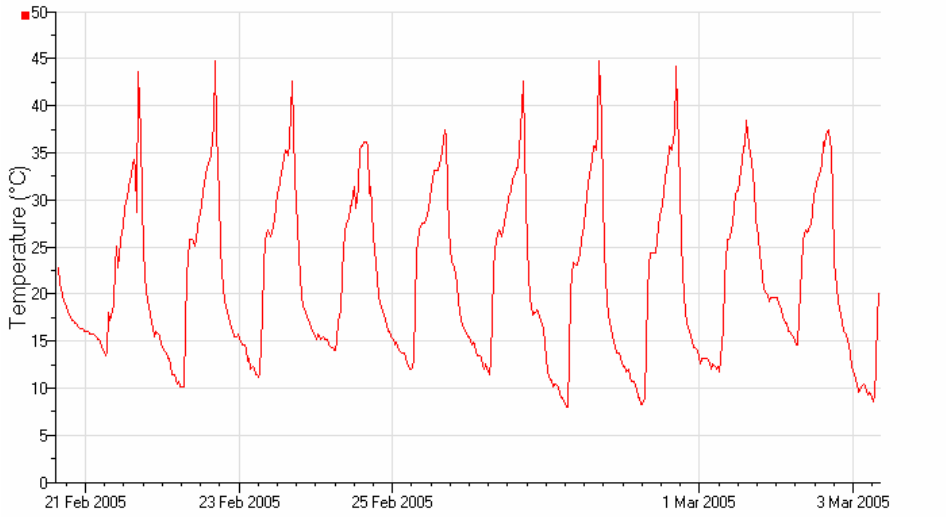


Fig. 57: 10A Bunchzone temperatures summer 05



11A On 25% east slope, n/s row orientation, smart dyson trellis

Fig. 58 11A Canopy facing east

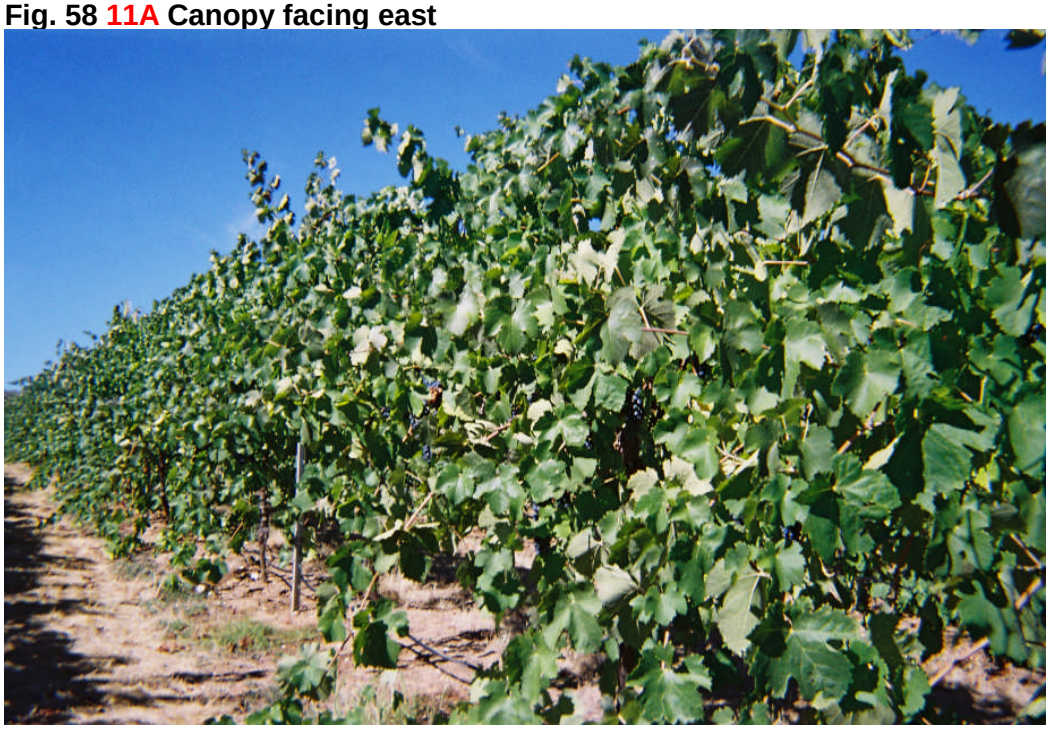


Fig. 59 11A Canopy facing west



Similar canopy structure as last year but morning heat more intense, some midday depression due to overhead foliage and afternoon heatloads again high until 6pm.

Fig. 60: 11A Bunch zone temperatures veraison to harvest - 24,209 degree hours in 40 days

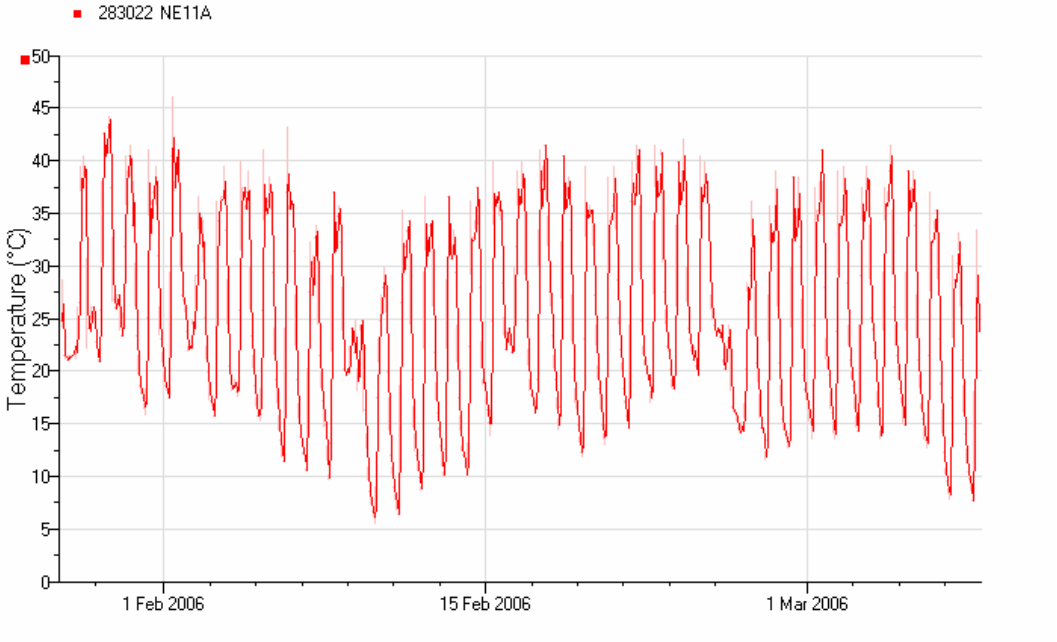


Fig. 61: 11A Bunch zone temperatures in summer 06

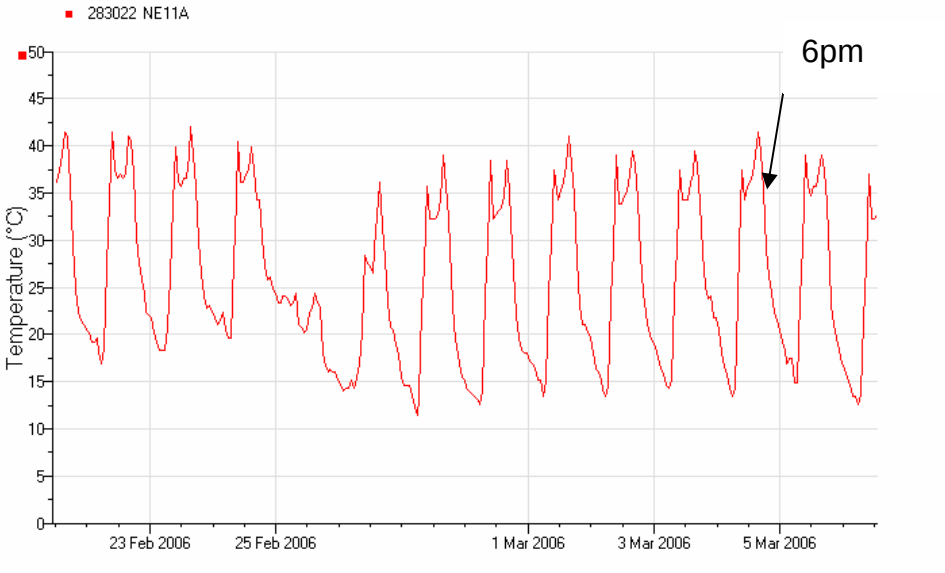
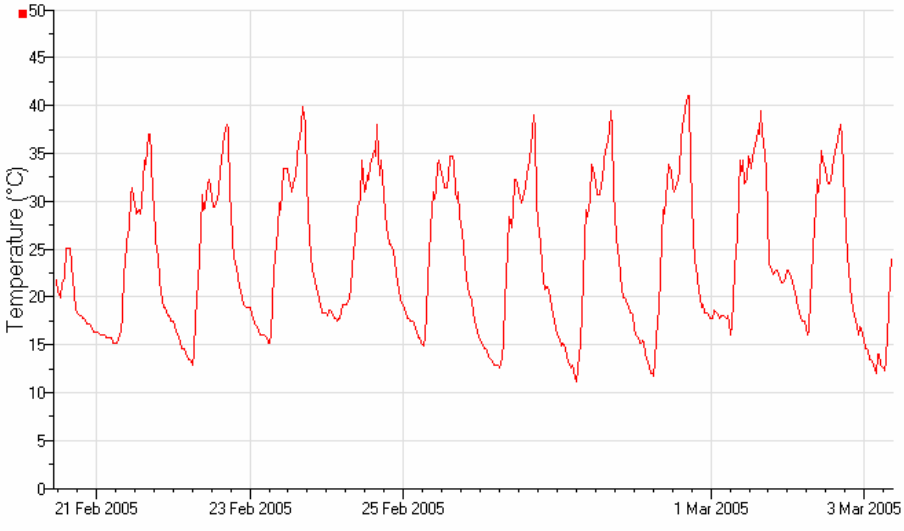


Fig. 62: 11A Bunch zone temperatures in summer 05



12B On 3% north slope, n/s row orientation, on a plateau,smart dyson trellis, light crop.

Fig. 63: 12B Canopy facing east

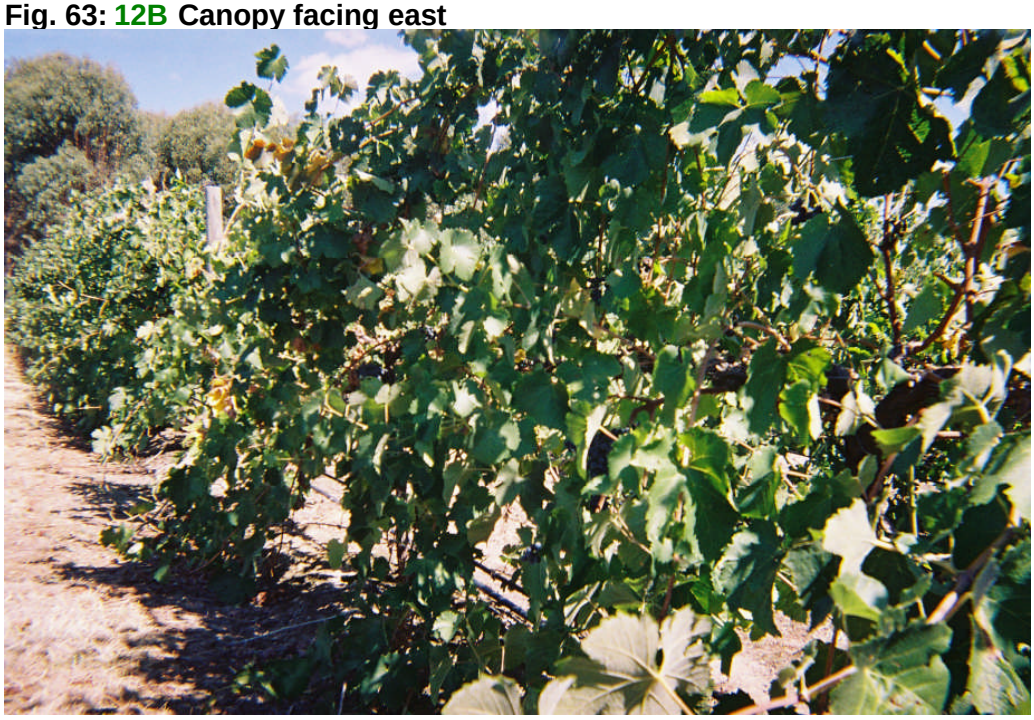
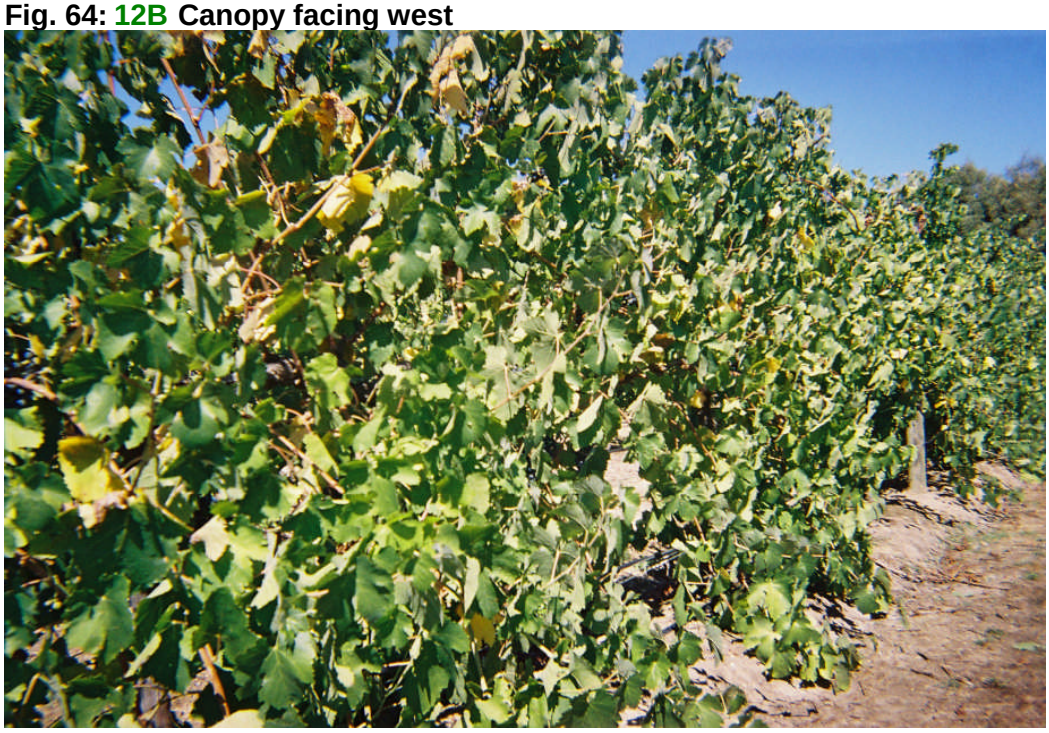


Fig. 64: 12B Canopy facing west



Faster ripening means lower heat summations, also warmer nights. Bunches reach 30C by 10am (first arrow), then have some overhead foliage inhibiting linear rise up to 2pm, then heatloads peaking at 4pm (third arrow) due to highly exposed bunches from dead leaves, particularly in the west.

Fig. 65: 12B Bunch zone temperatures veraison to harvest - 20,921 degree hours in 39 days

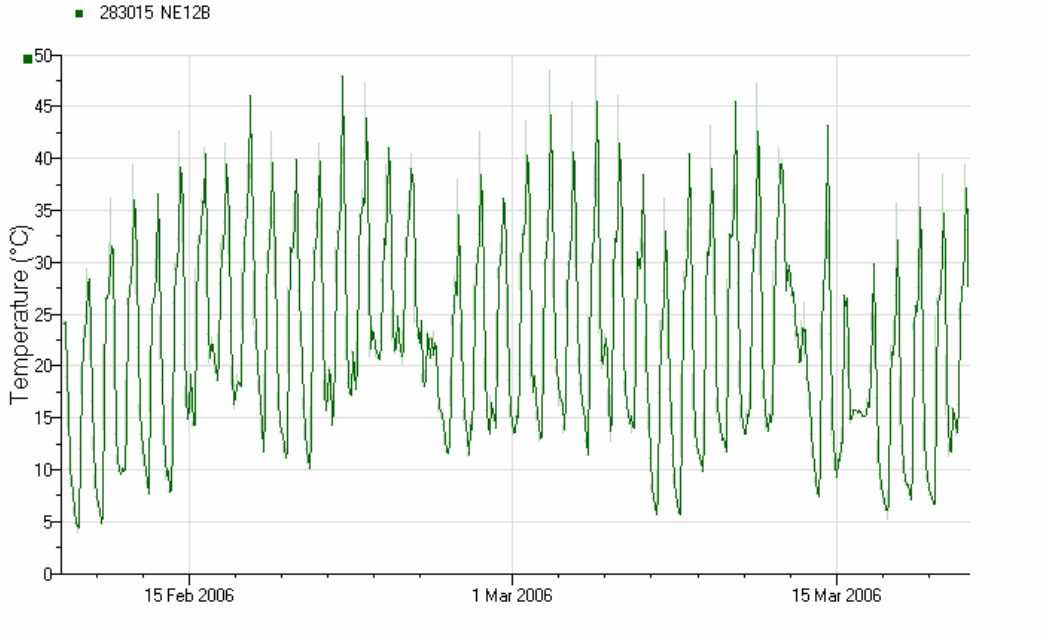


Fig.66: 12B Bunch zone temperatures summer 06

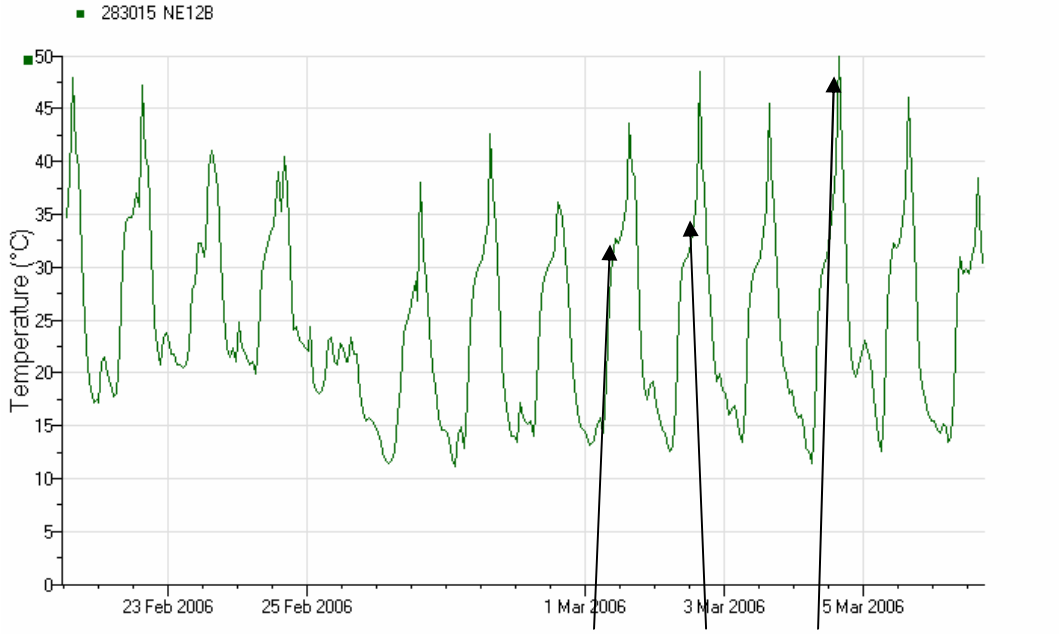
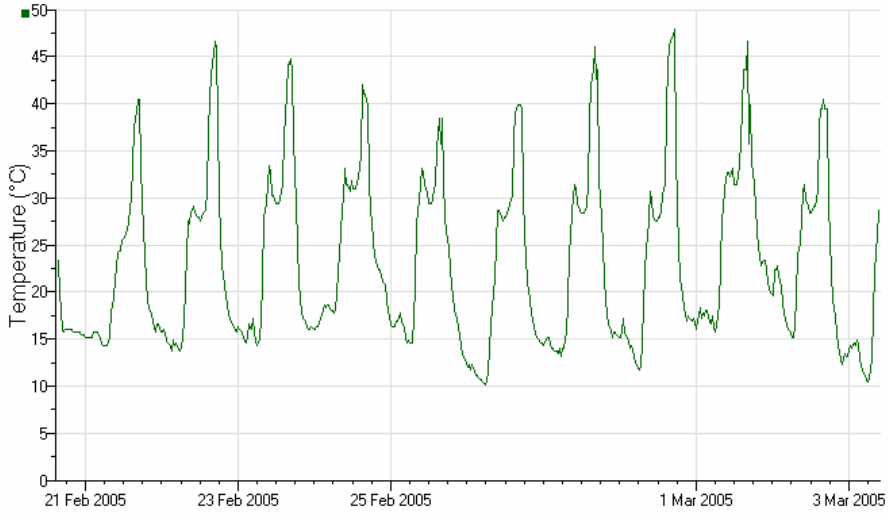


Fig. 67: 12B Bunch zone temperatures summer 05



13G On 3% wsw slope, nw/se row orientation, rainfed VSP east of a large lake.

Fig. 68: 13G Canopy facing north east, drought stressed leaves

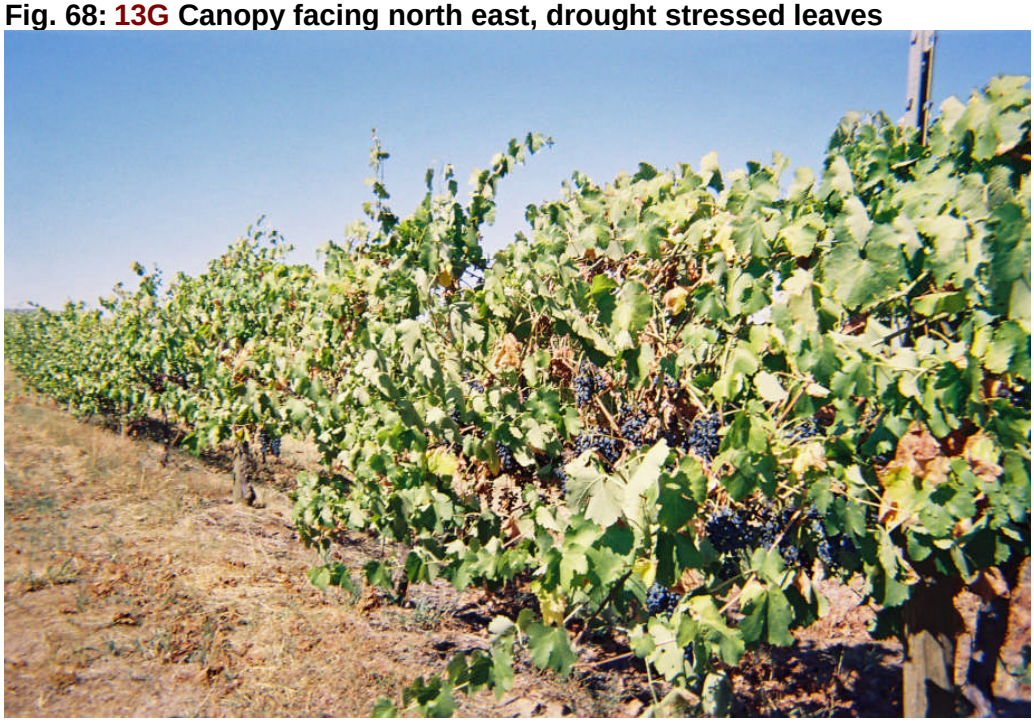


Fig. 69: 13G Canopy facing south west



This vineyard is protected from hot northerly winds by a cool-off effect of the extremely large water surface to the east. Beneficial bunch temperatures more due to the mesoclimate than to canopy management, which displays many dead leaves and exposed bunches due to dry conditions (10% shrivel).

Fig. 70: 13G Bunch zone temperatures veraison to harvest - 24,059 degree hours in 40 days

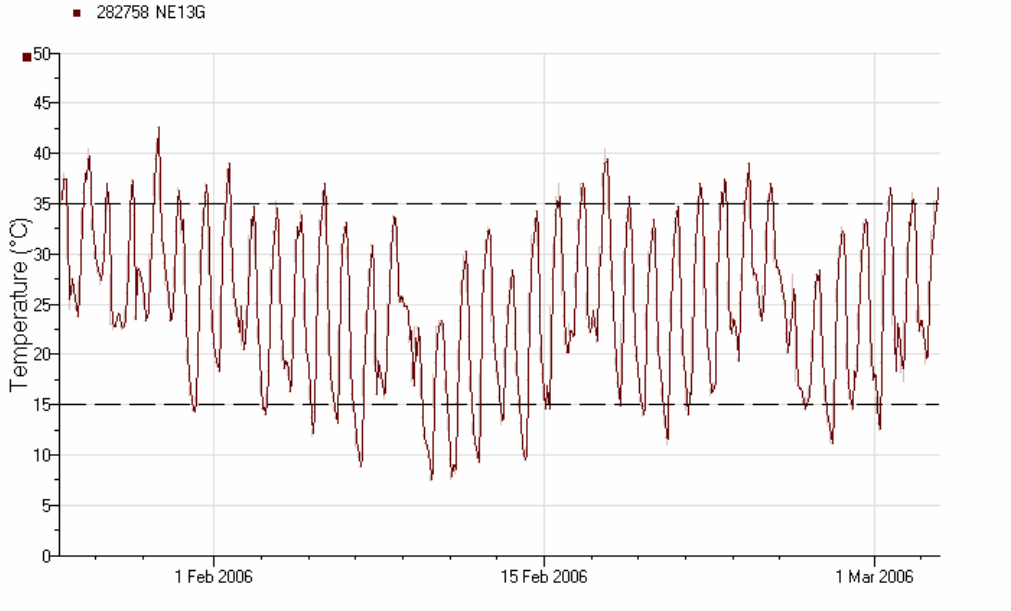


Fig. 71: 13G Bunch zone temperatures summer 06

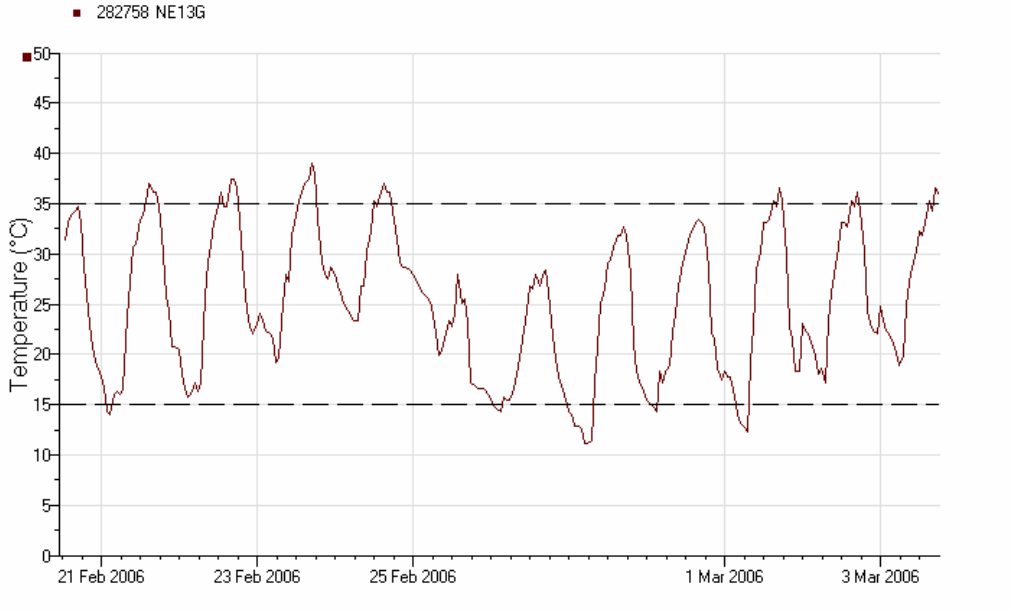
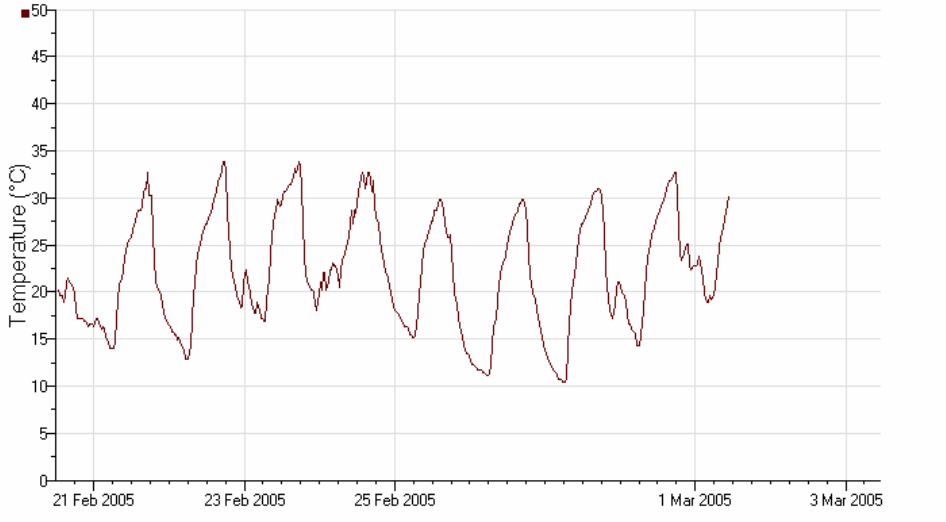


Fig. 72: 13G Bunch zone temperatures summer 05



14K On flat terrain, n/s row orientation, smart dyson trellis

Fig. 73: 14K Canopy facing east



Fig. 74: 14K Canopy facing west



Again like last year poor bunch exposure.

Fig. 75: 14K Bunch zone temperatures veraison to harvest – 26,869 degree hours in 60 days

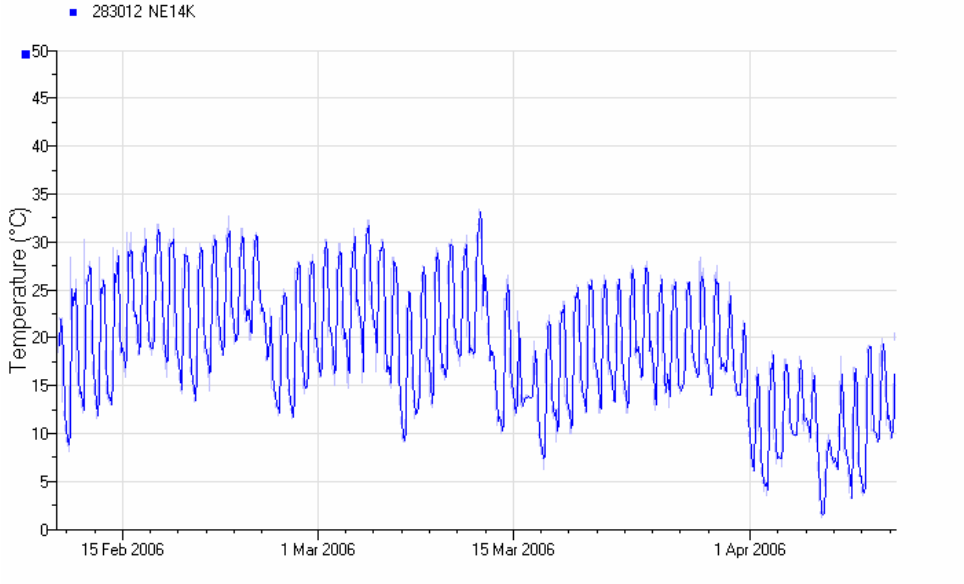


Fig. 76: 14K Bunch zone temperatures summer 06

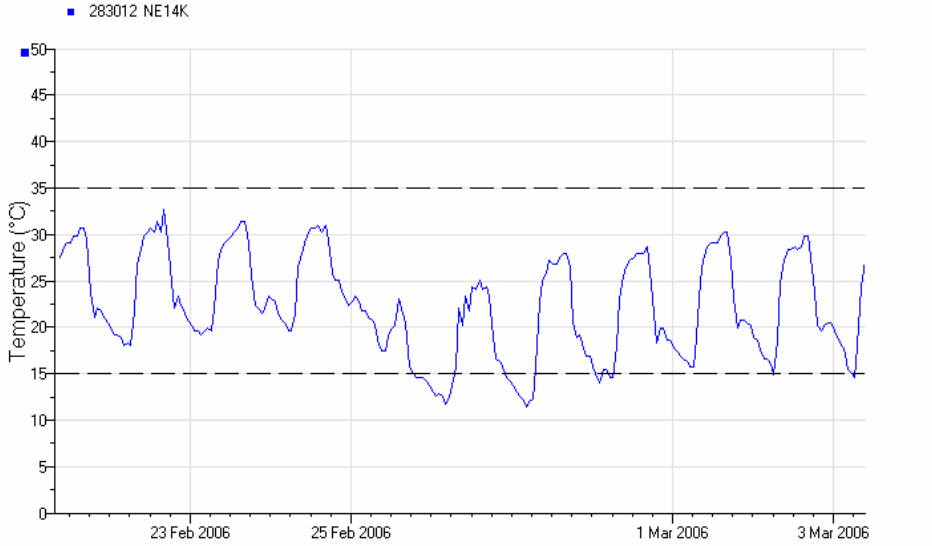
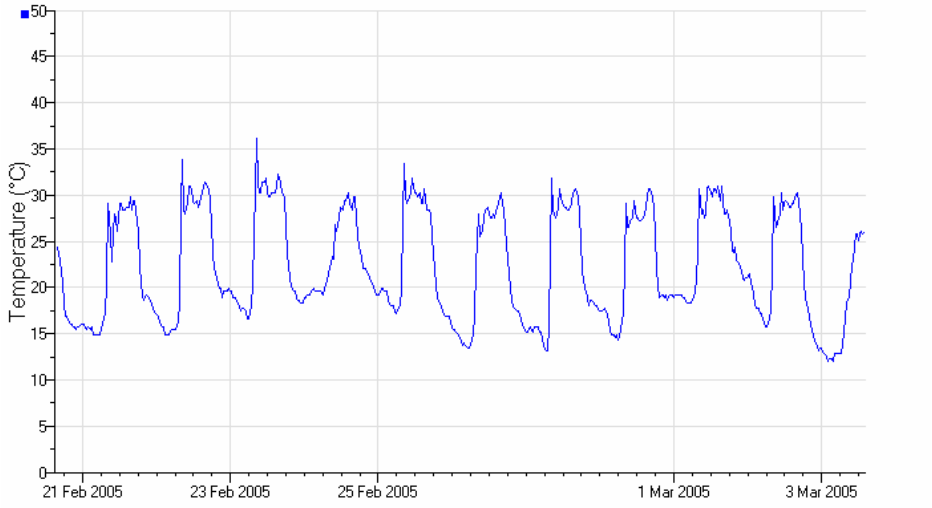


Fig. 77: 14K Bunch zone temperatures summer 05



15R On 3% west slope, e/w row orientation, scott henry trellis

Fig. 78: 15R Canopy facing north



Fig. 79: 15R Canopy facing south



Warmer than last year due to warm nights (hot winds?) and dead leaves over the north facing bunches resulting in heatloads with a sharp decline of heat after 4pm (arrow).

Fig. 80: 15R Bunch zone temperatures veraison to harvest – 24,989 degree hours in 39 days

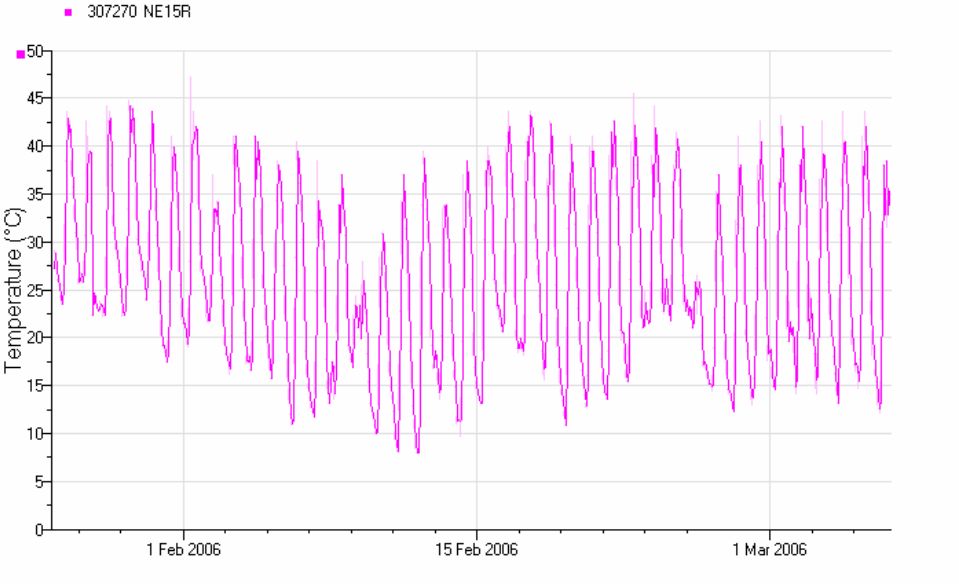


Fig. 81: 15R Bunch zone temperatures summer 06

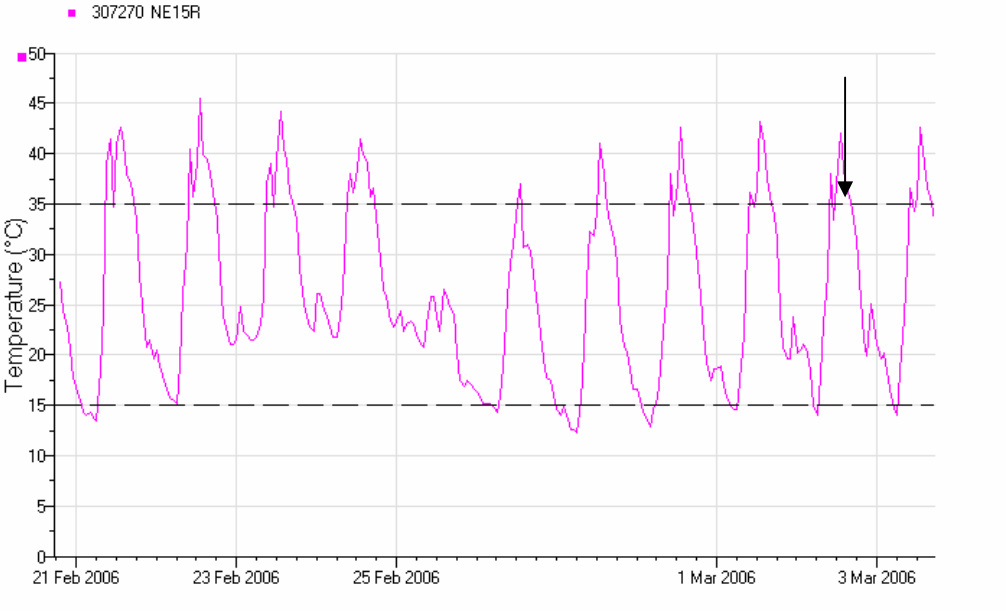
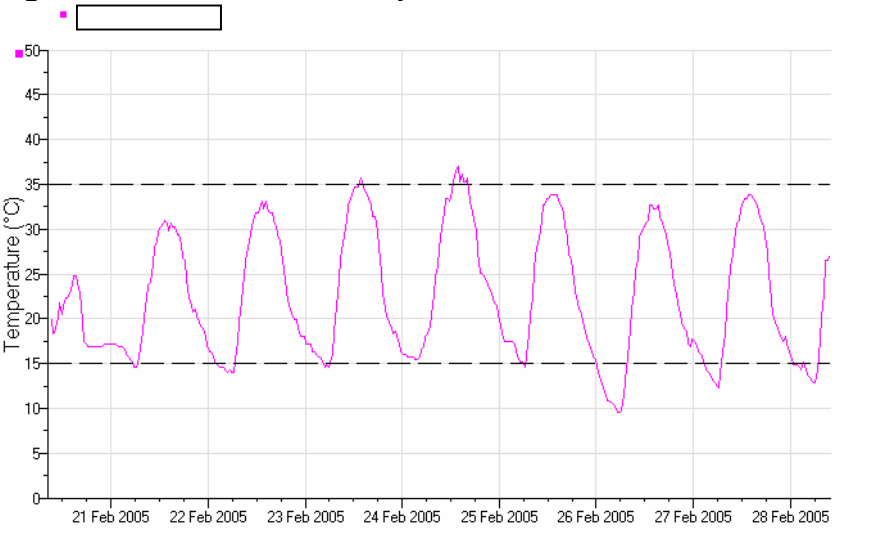


Fig. 82: 15R Bunch zone temperatures summer 05



16R On 5% ne slope, ne/sw row orientation, scott henry trellis

Fig. 83: 16R Canopy facing north west, drought stressed leaves

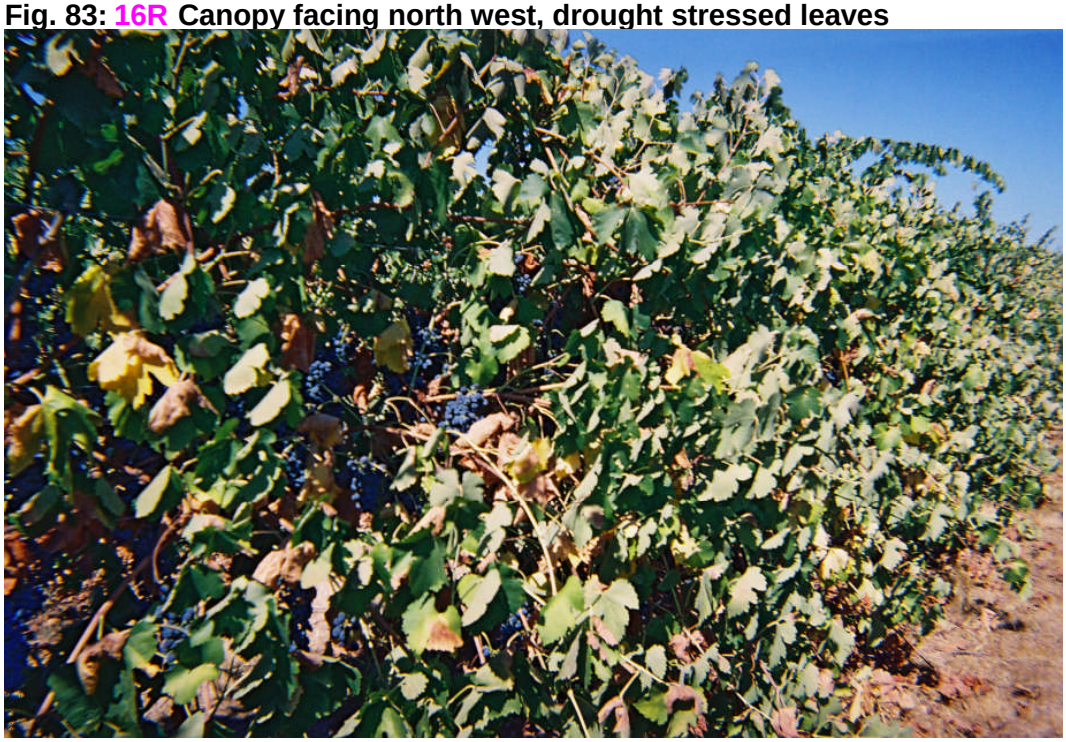


Fig. 84: 16R Canopy facing south east



Highly exposed bunches due to leaf loss on hot N/W side.

Fig. 85: 16R Bunch zone temperatures veraison to harvest - 24,370 degree hours in 42 days

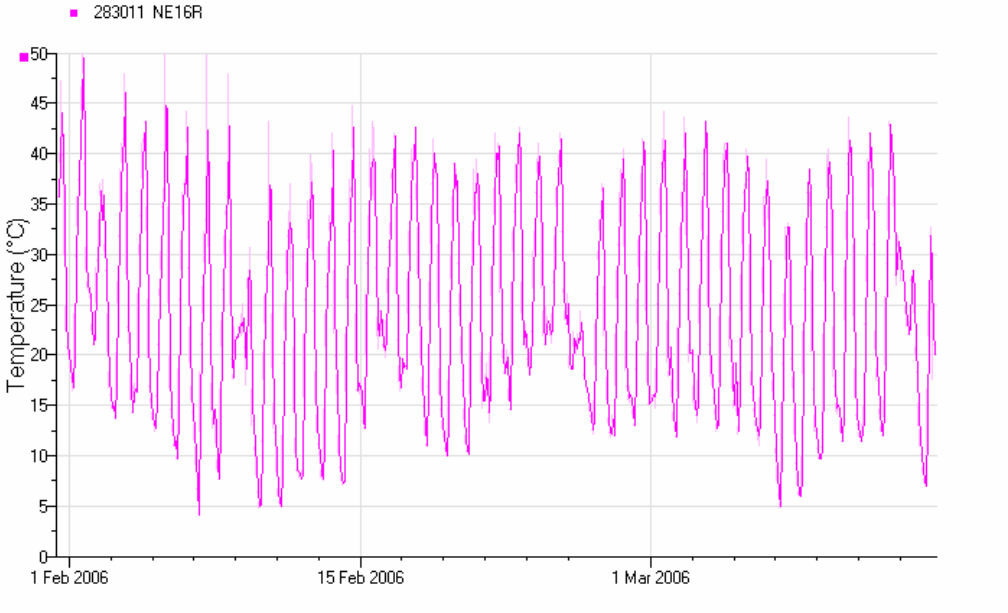


Fig. 86: 16R Bunch zone temperatures summer 06

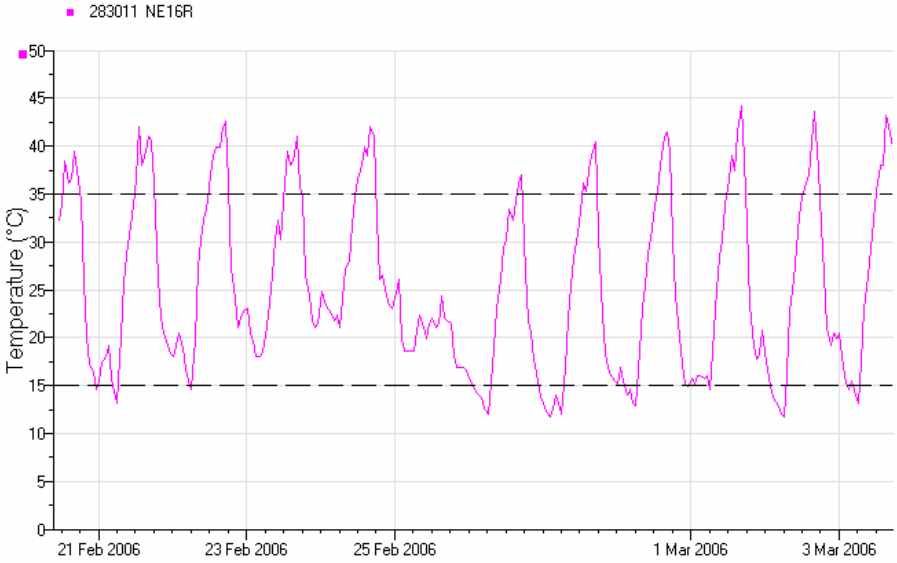
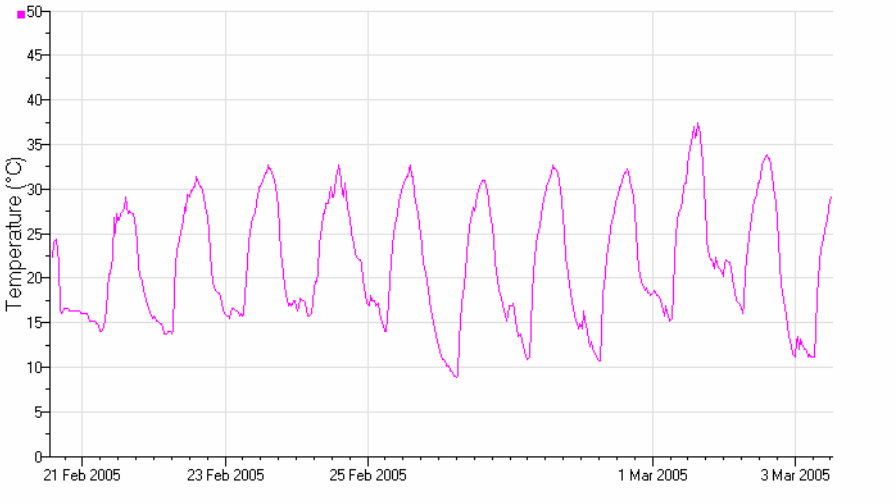


Fig. 87: 16R Bunch zone temperatures summer 05



17G On 5% sw slope, nw/se row orientation, VSP trellis

Fig. 88: 17G Canopy facing north east (morning sun)



Fig. 89: 17G Canopy facing south west



This vineyard had similar conditions as last year.

Fig. 90: 17G Bunch zone temperatures veraison to harvest - 15,908 degree hours in 26 days (logger installed a week later than 50 % veraison)

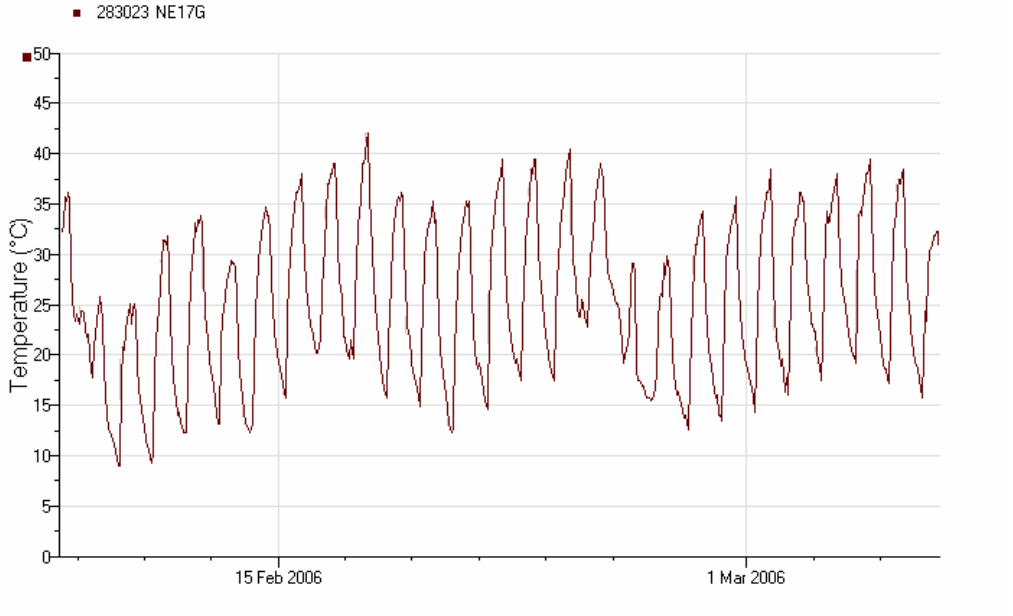


Fig. 91: 17G Bunch zone temperatures summer 06

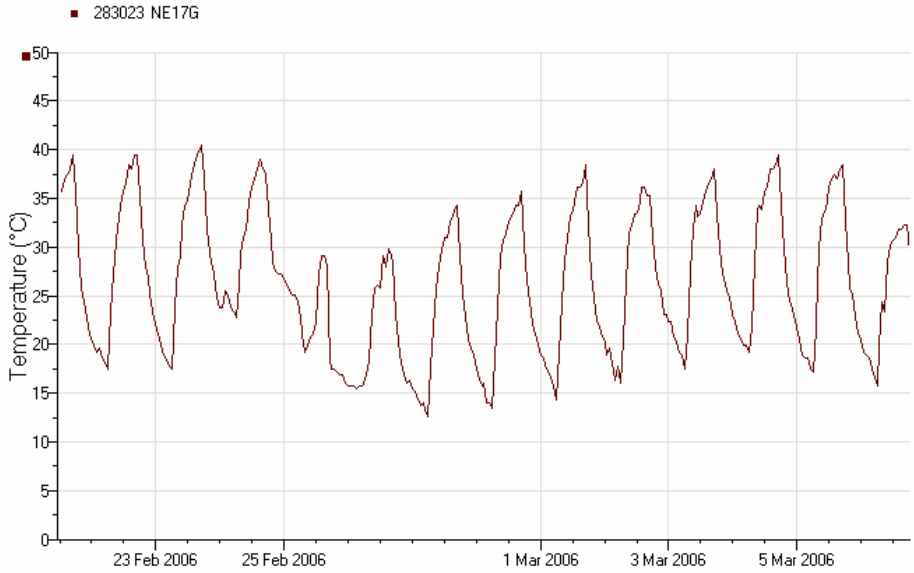
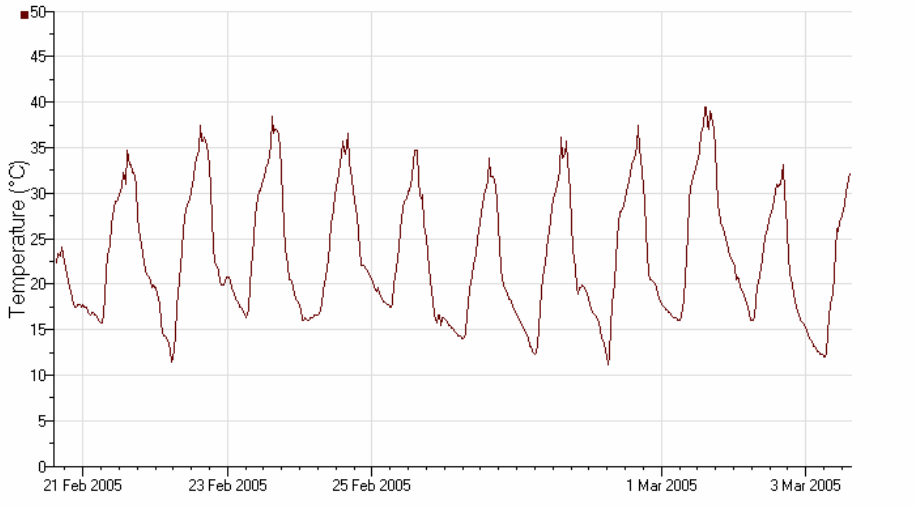


Fig. 92: 17G Bunch zone temperatures summer 05



18G On 3% ne slope, n/s row orientation, smart dyson trellis, hot side of hill.

Fig. 93: 18G Canopy facing east



Fig. 94: 18G Canopy facing west, drought stressed leaves



Vineyard hot as in last year but this year fast ripening (with half of the crop load compared to last year). High afternoon heatloads due to leaf loss from veraison to harvest.

Fig. 95: 18G Bunch zone temperature veraison to harvest - 29,941 degree h in 47d

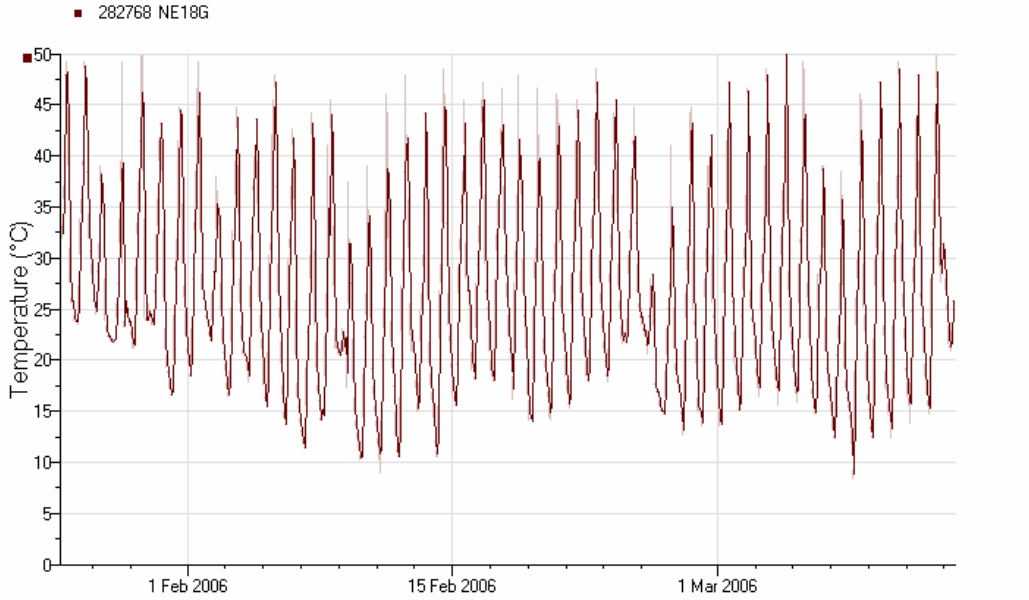


Fig. 96: 18G Bunch zone temperature summer 06

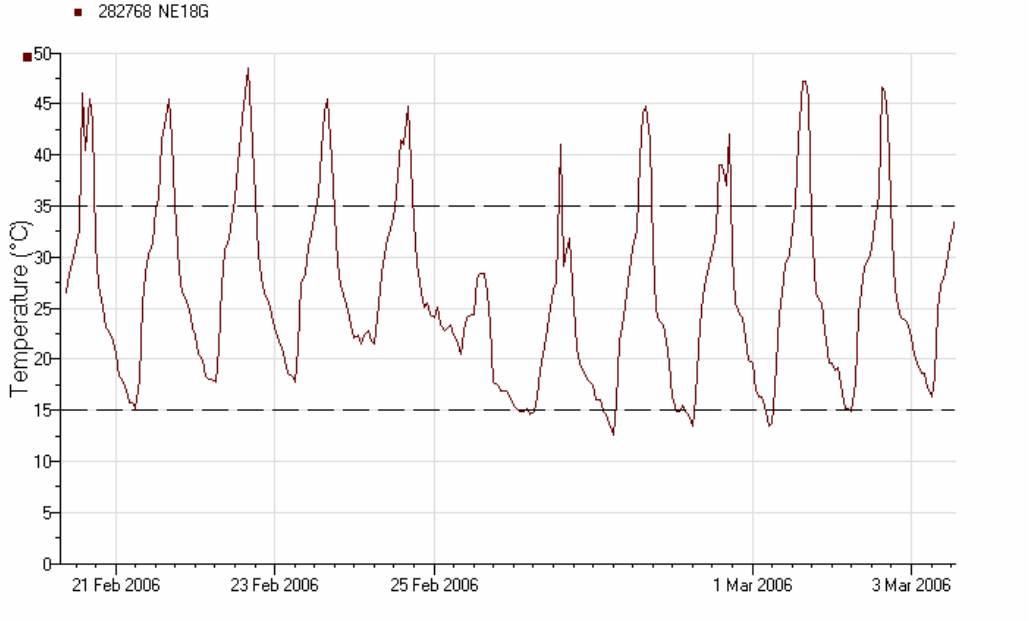
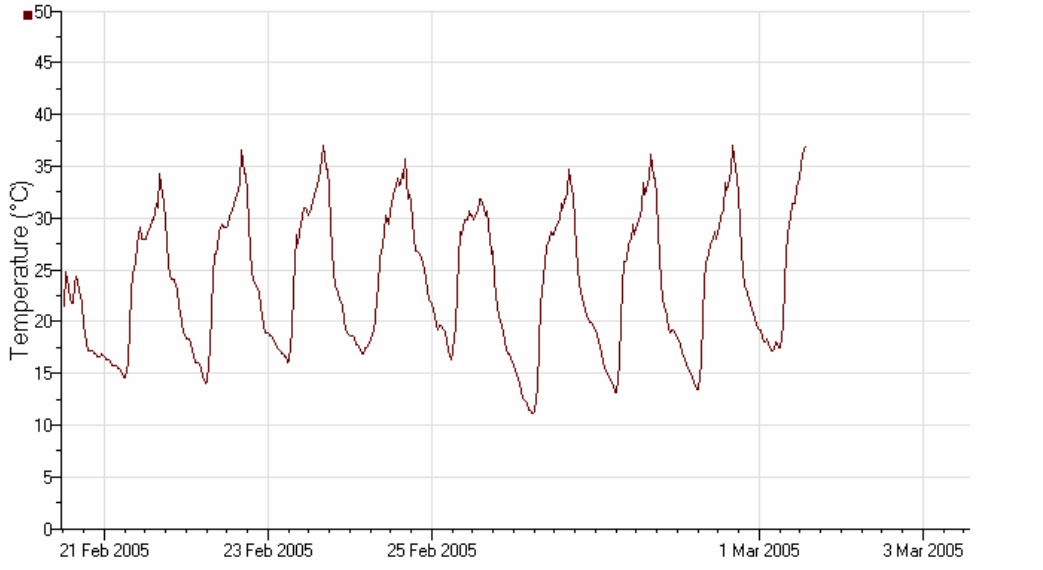


Fig. 97: 18G Bunch zone temperature summer 05



19B On 10% north slope, n/s row orientation, smart dyson trellis

Fig. 98: 19B Canopy facing east



Fig. 99: 19B Canopy facing west



Heatloads only early in season, but of long duration. Due to the low vigour of the vines bunches are quite exposed, but ripened off in cooler part of the season.

Fig. 100: 19B Bunch zone temperatures January to March

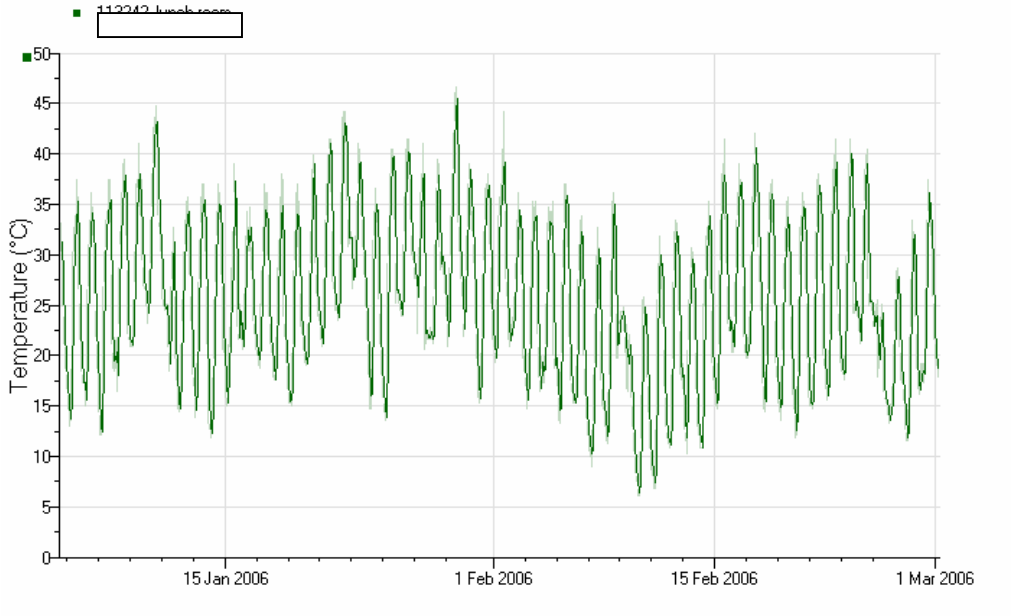


Fig. 101: 19B Bunch zone temperatures early summer 06

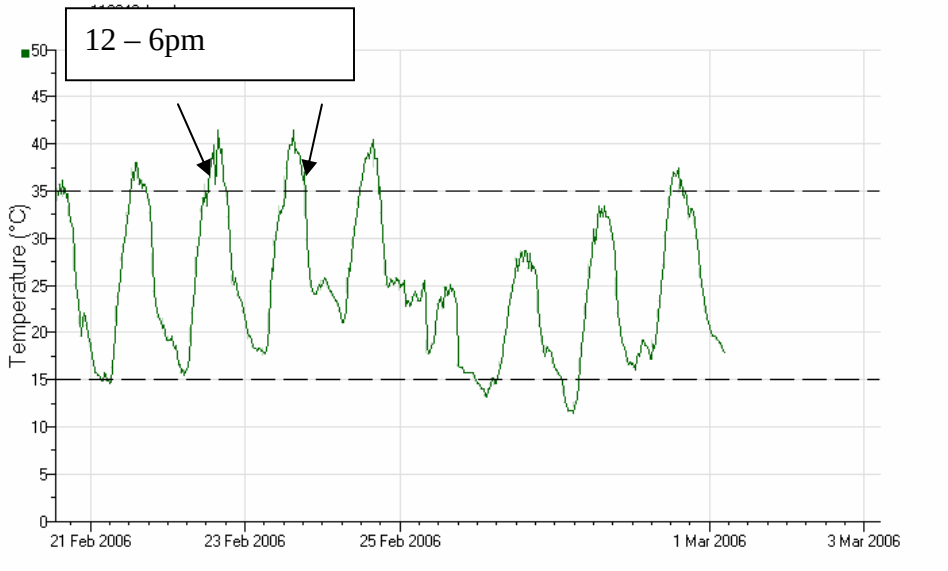


Fig. 102: 19B Bunch zone temperatures early summer 05

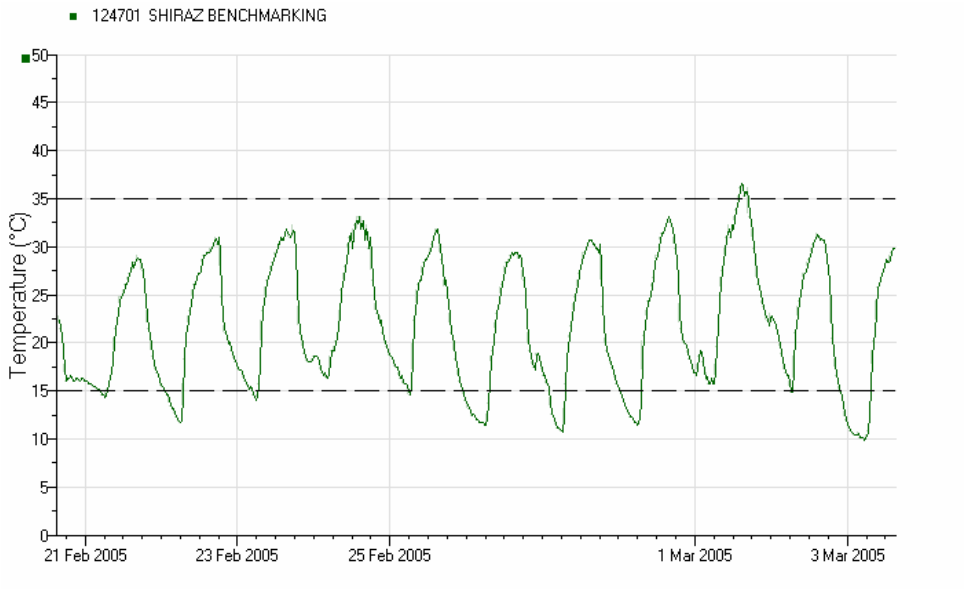
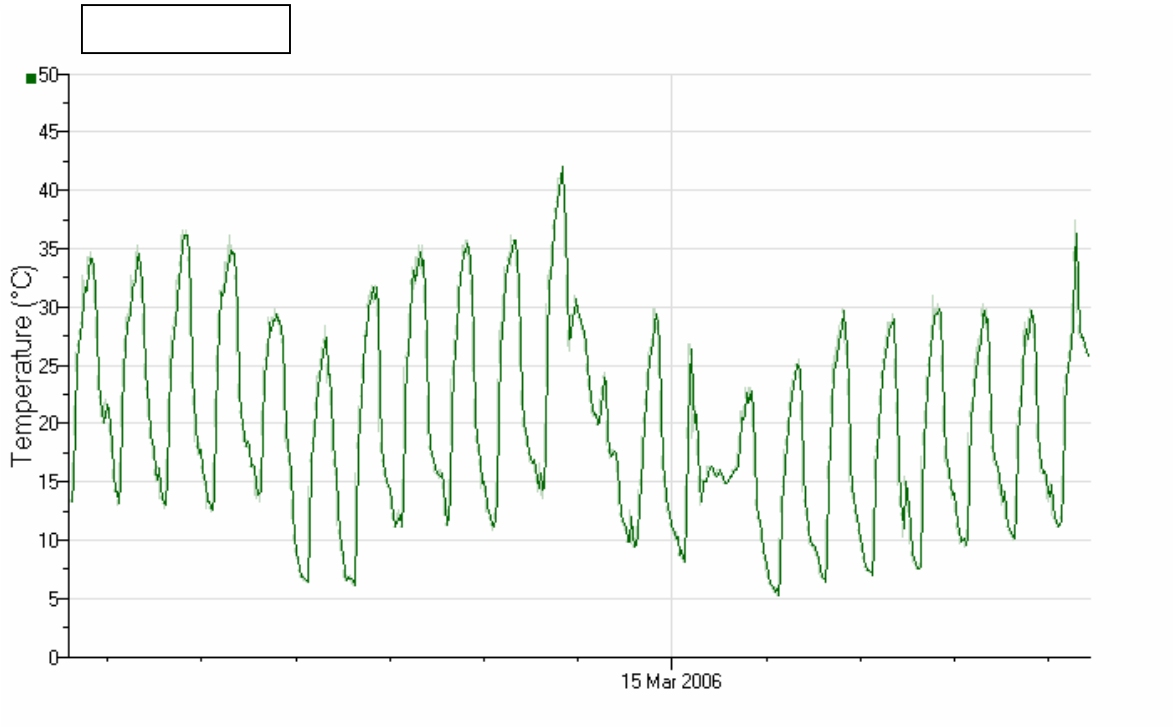


Fig. 103: 19B Bunch zone temperatures March 2006
pre harvest period
Veraison to harvest 24,096 degree hours in 44 days

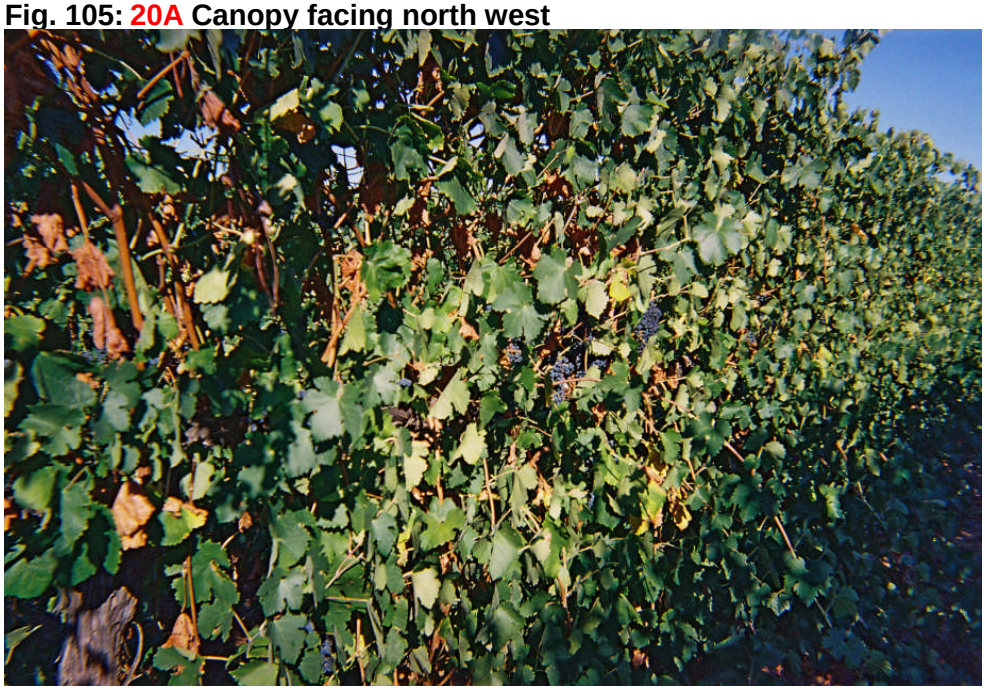


20A On flat terrain, ne/sw row orientation, smart dyson trellis

Fig. 104: 20A Canopy facing south east



Fig. 105: 20A Canopy facing north west



It is 20 degrees at 6am from which bunchzone temperatures rise steeply to 36-40 degrees at 10pm, the worst heat is fended off on most days by overhead foliage (dip in temperature) 35 degrees is only reached at 5pm in Feb. but at 2pm in March.

Fig. 106: 20A Bunch zone temperatures veraison to harvest - 27,116 degree hours in 46 days

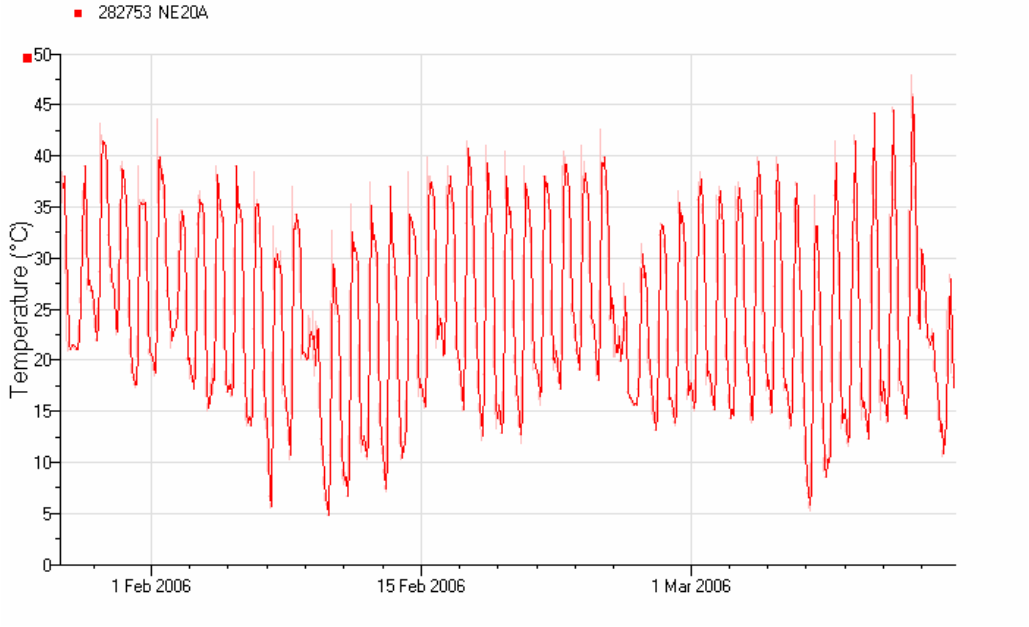
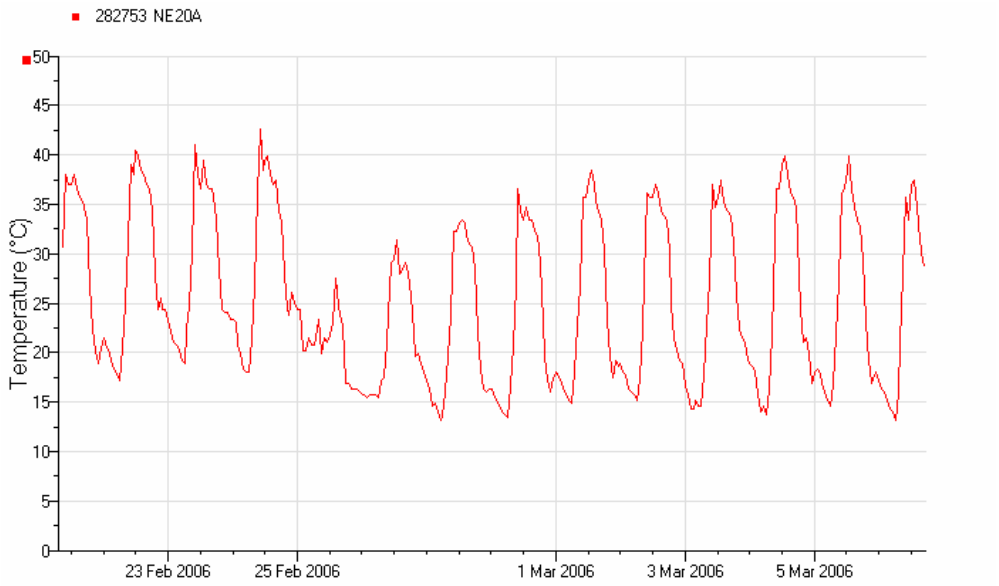


Fig. 107: 20A Bunch zone temperatures summer 06



Bunch zone temperatures summer 05 not available

21B On 25% west slope, e/w row orientation, VSP trellis

Fig. 108: 21B Canopy facing north



Fig. 109: 21B Canopy facing south



Canopy management similar to last year but generally warmer nights and days, avoided heatloads in afternoon

Fig. 110: 21B Bunch zone temperatures veraison to harvest - 18,958 degree hours in 32 days

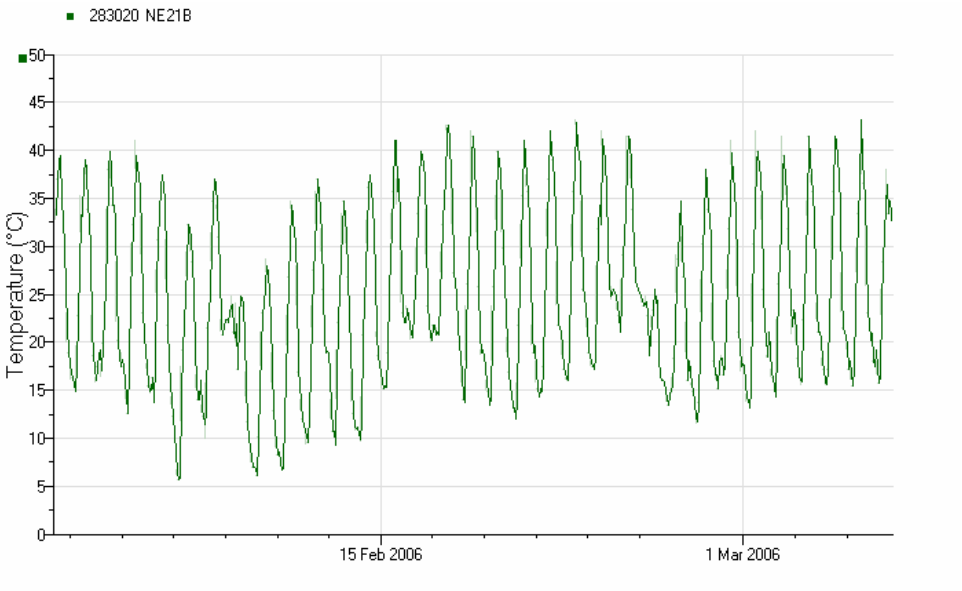


Fig. 111: 21B Bunch zone temperatures summer 06

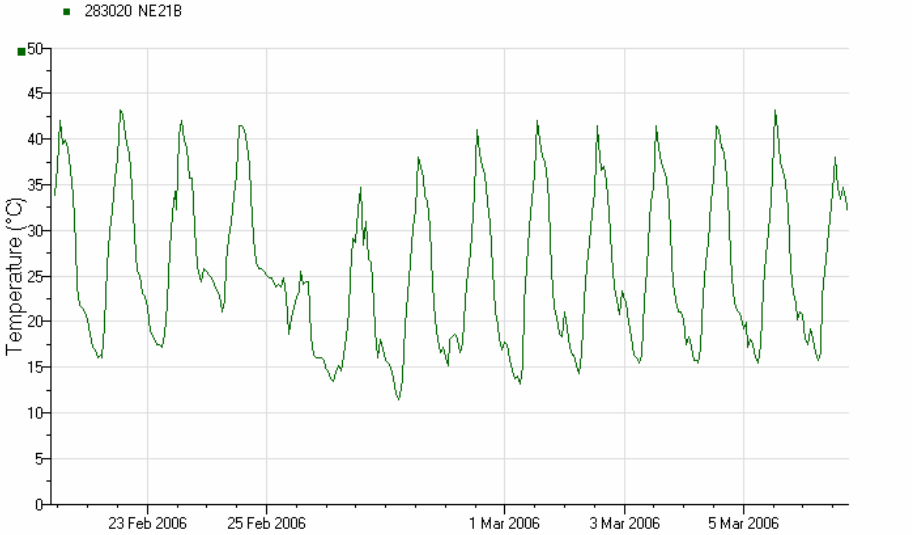
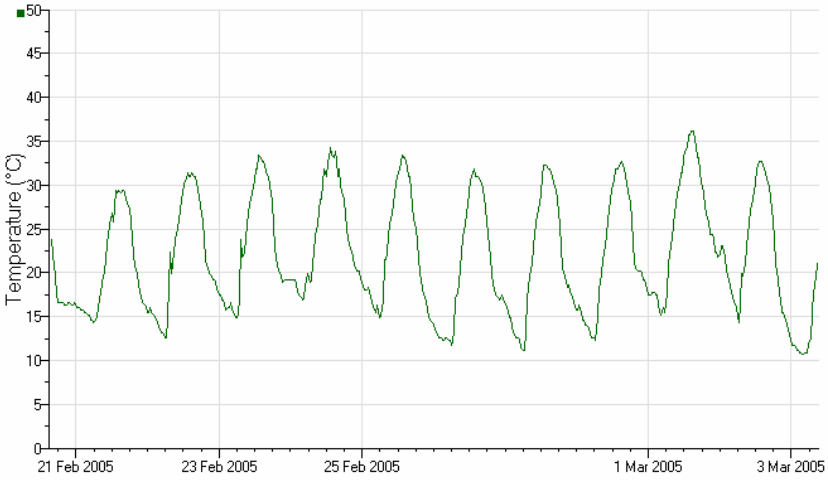


Fig. 112: 21B Bunch zone temperatures summer 05



22G On 5% nnw slope, ne/sw row orientation, sprawling canopy,

Fig. 113: 22G Canopy facing north west



Fig. 114: 22G Canopy facing south east



Fast ripening saved the crop from excessive heat summation. Heat loads from 11 am (arrow), daily maximum at 2pm, 45 C on hot days. North westerly hot winds rolling shoots to the south east exposing bunches to afternoon sun. Basal leaf loss, some hot winds at midnight?

Fig.115: 22G Bunch zone temperatures veraison to harvest - 27,402 degree hours in 46 days

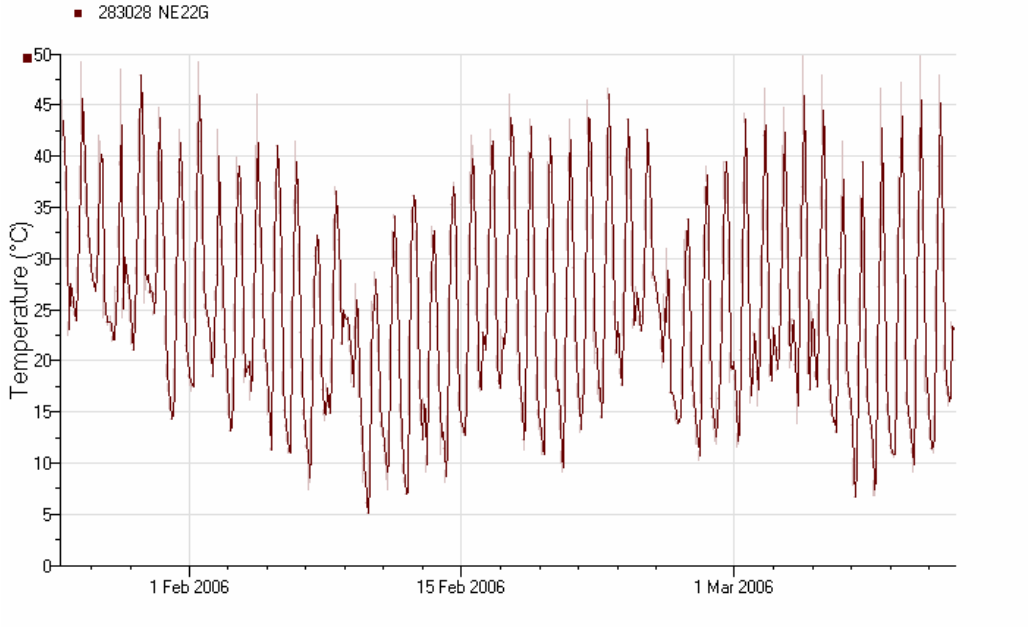


Fig. 116: 22G Bunch zone temperatures summer 06

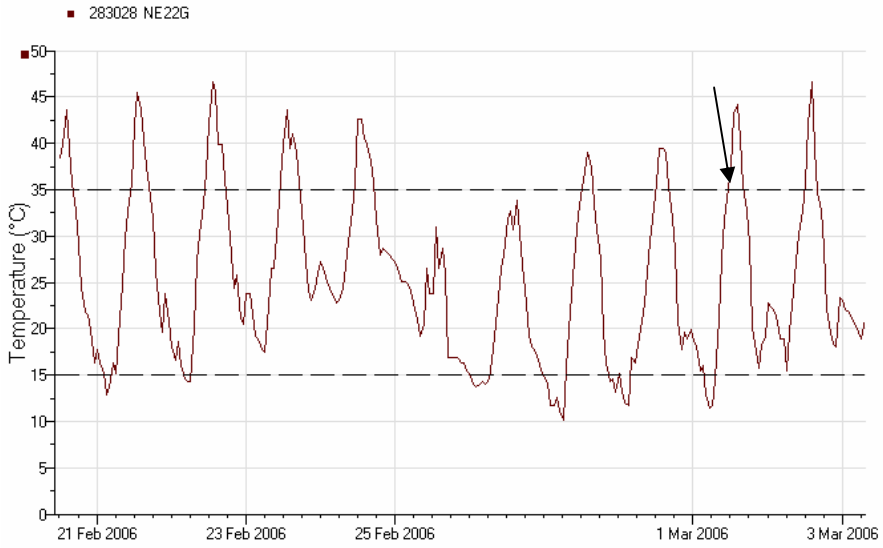
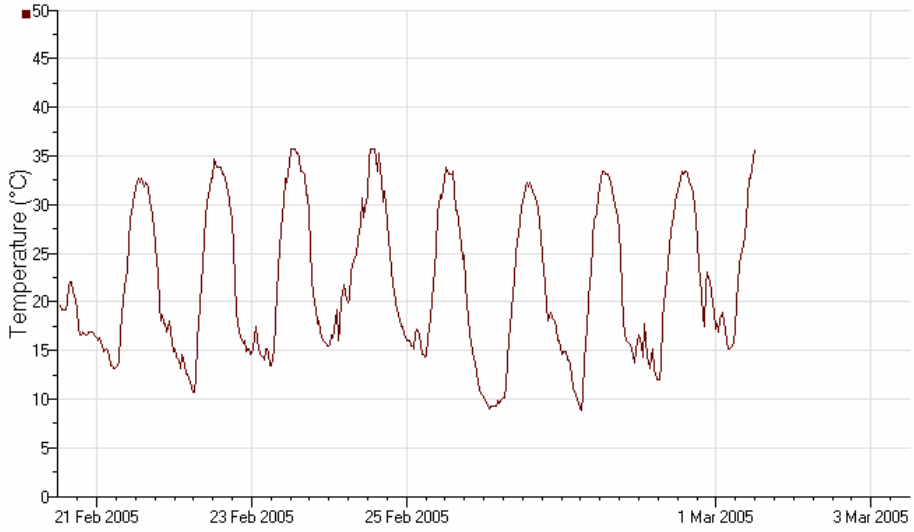


Fig. 117: 22G Bunch zone temperatures summer 05



23K On 10% north slope, e/w row orientation, smart dyson trellis

Fig. 118: 23K Canopy facing north



Fig. 119: 23K Canopy facing south



Similar ripening period and management as last year except capped heatloads in the morning as this year the leaves were not plucked on north side. Good avoidance of afternoon heatloads.

Fig.120: 23K Bunch zone temperatures veraison to harvest - 21,777 degree hours in 39 days

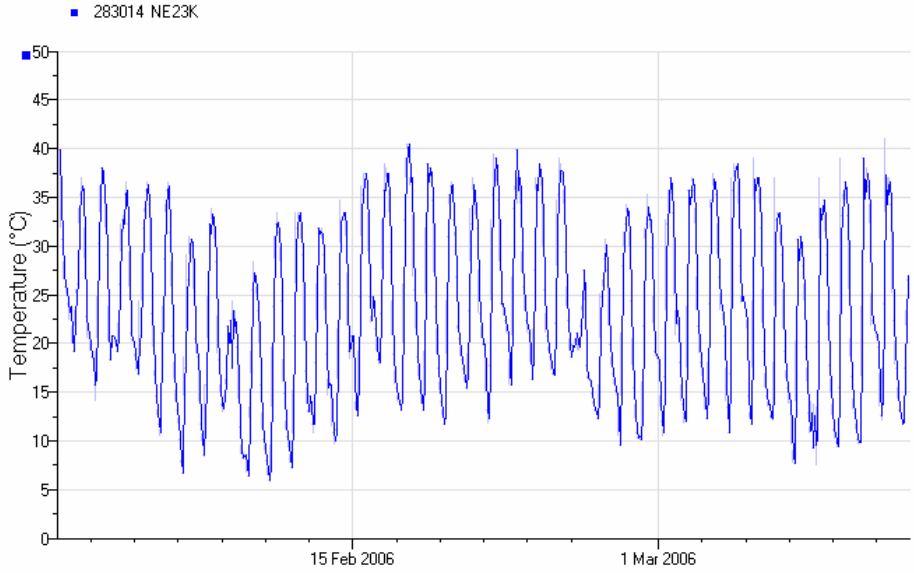


Fig. 121: 23K Bunch zone temperatures summer 06

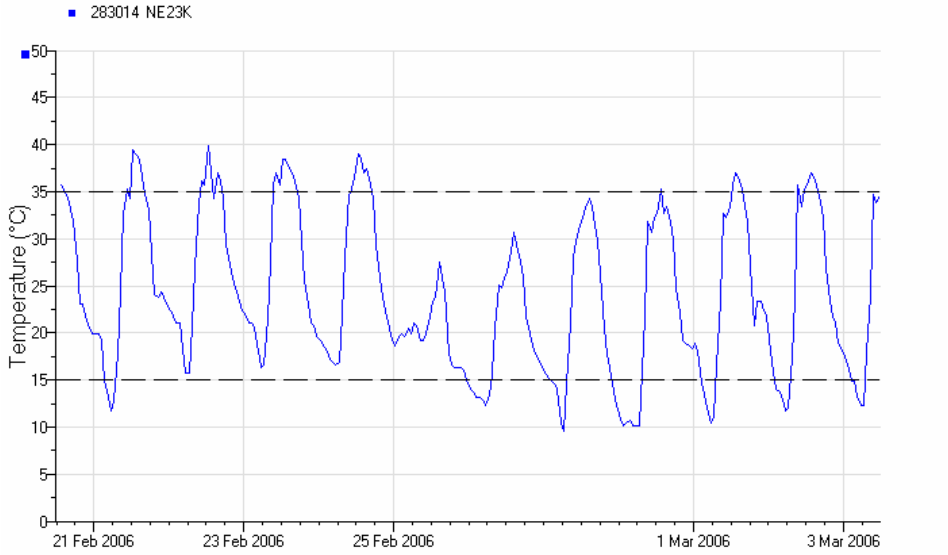
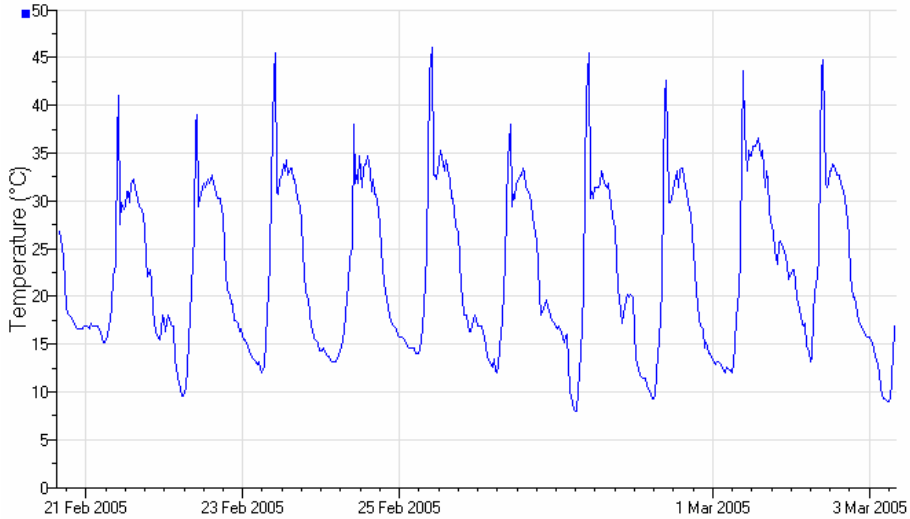


Fig. 122: 23K Bunch zone temperatures summer 05



24R On flat terrain, n/s row orientation, scott henry trellis

Fig. 123: 24R Canopy facing east



Fig. 124: 24R Canopy facing west



High heat summations due to severe heatloads early season. Later in the season (Fig. 103) two phases of heat occurrence: first peak 9am, second peak 4pm, between that temperature drop via foliage protection. Some areas of highly exposed bunches.

Fig. 125: 24R Bunch zone temperatures veraison to harvest - 34,203 degree hours in 54 days

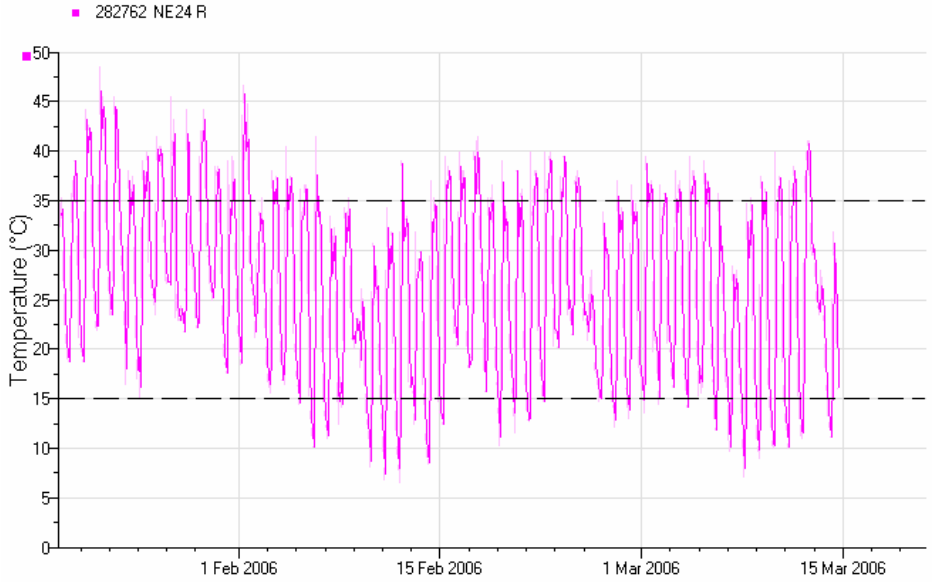


Fig. 126: 24R Bunch zone temperatures summer 06

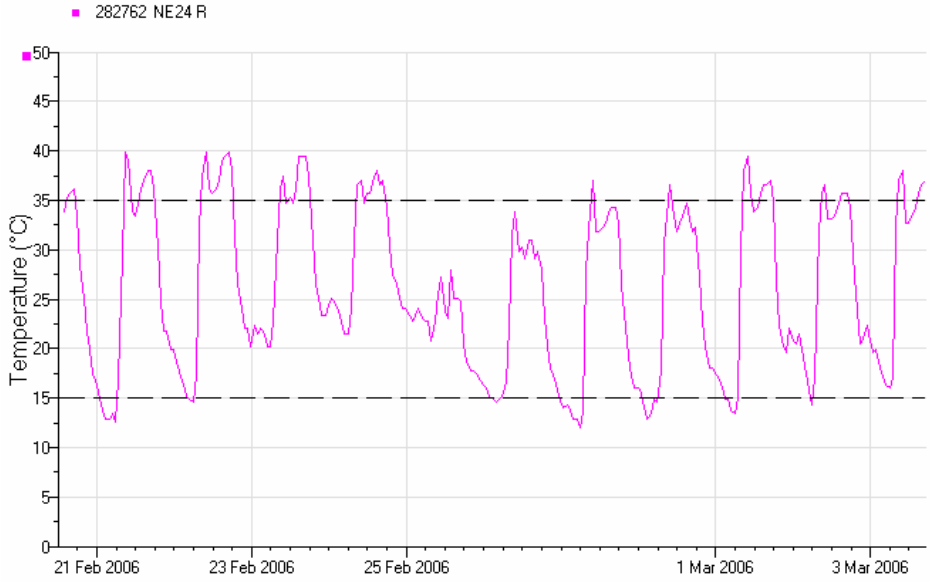
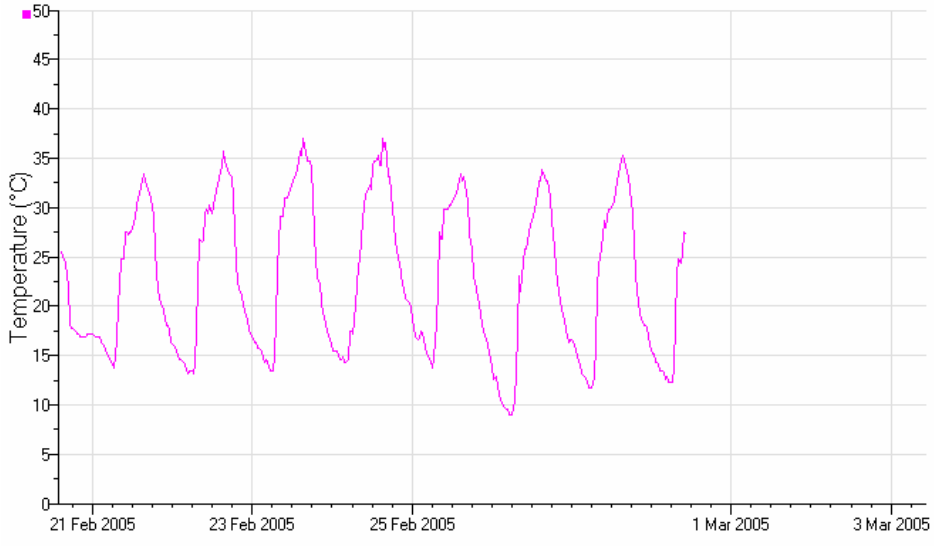


Fig. 127: 24R Bunch zone temperatures summer 05



25K On 15% west slope, n/s row orientation, smart dyson trellis, plucked on east

Fig. 128: 25K Canopy facing east



Fig. 129: 25K Canopy facing west



Warmer year, smaller crop, faster ripening, heatloads in the afternoon (12 -5pm) due to less overhead foliage.

Fig. 130: 25K Bunch zone temperatures veraison to harvest - 22,180 degree hours in 39 days

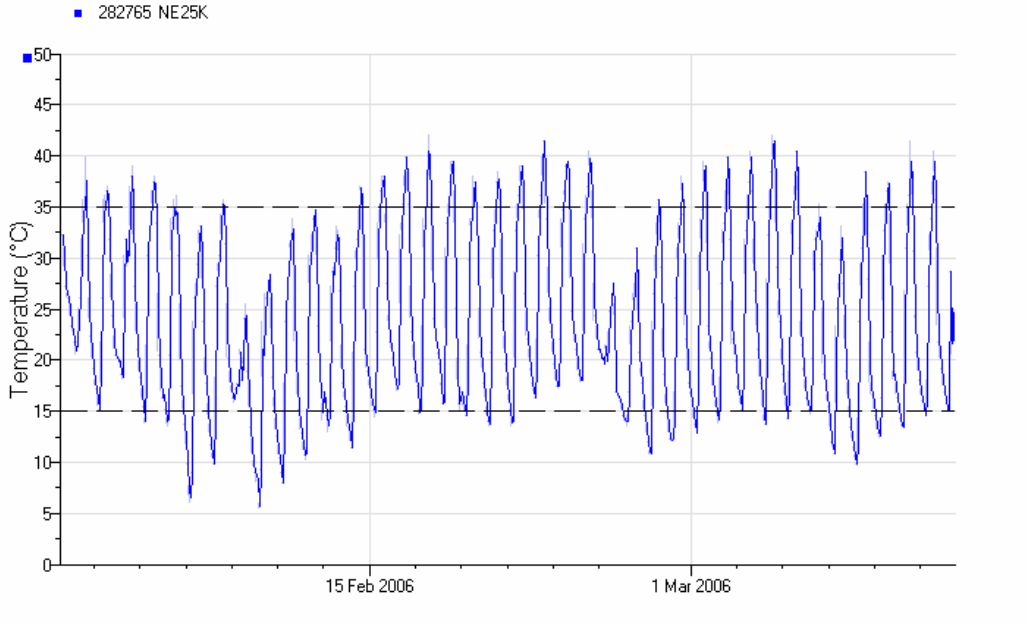


Fig. 131: 25K Bunch zone temperatures summer 06

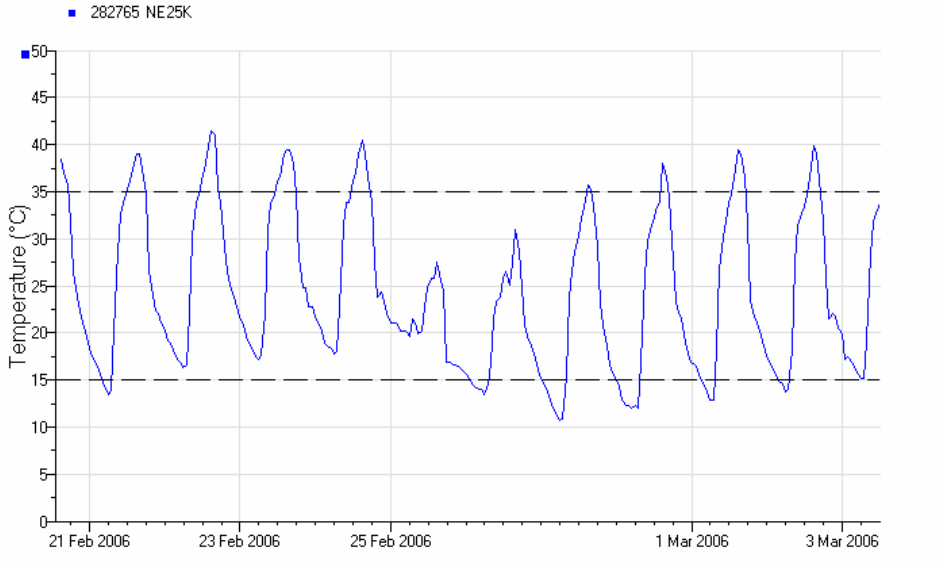
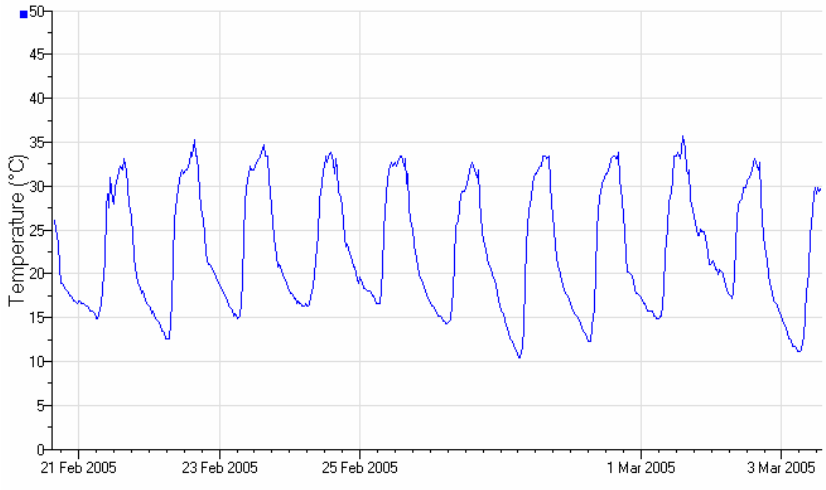


Fig. 132: 25K Bunch zone temperatures summer 05



26GN On 10% sw slope, nw/se row orientation, smart dyson trellis, box hedge pruned

Fig. 133: 26GN Canopy facing north east



Fig. 134: 26GN Canopy facing south west



Heatloads early season. Fast rising temperatures in the morning with highly exposed bunches to the north east due to hedging. Foliage cover to the south west. Hot winds at night?

Fig. 135: 26GN Bunch zone temperature veraison to harvest - 24,170 degree hours in 40 days

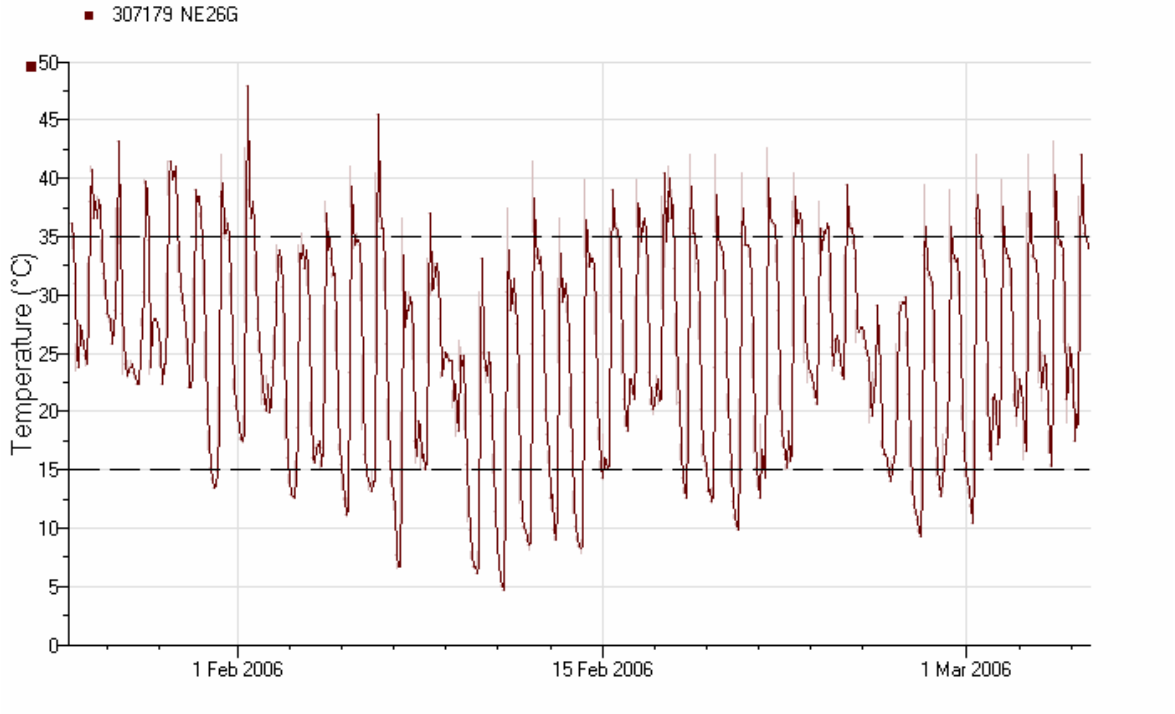
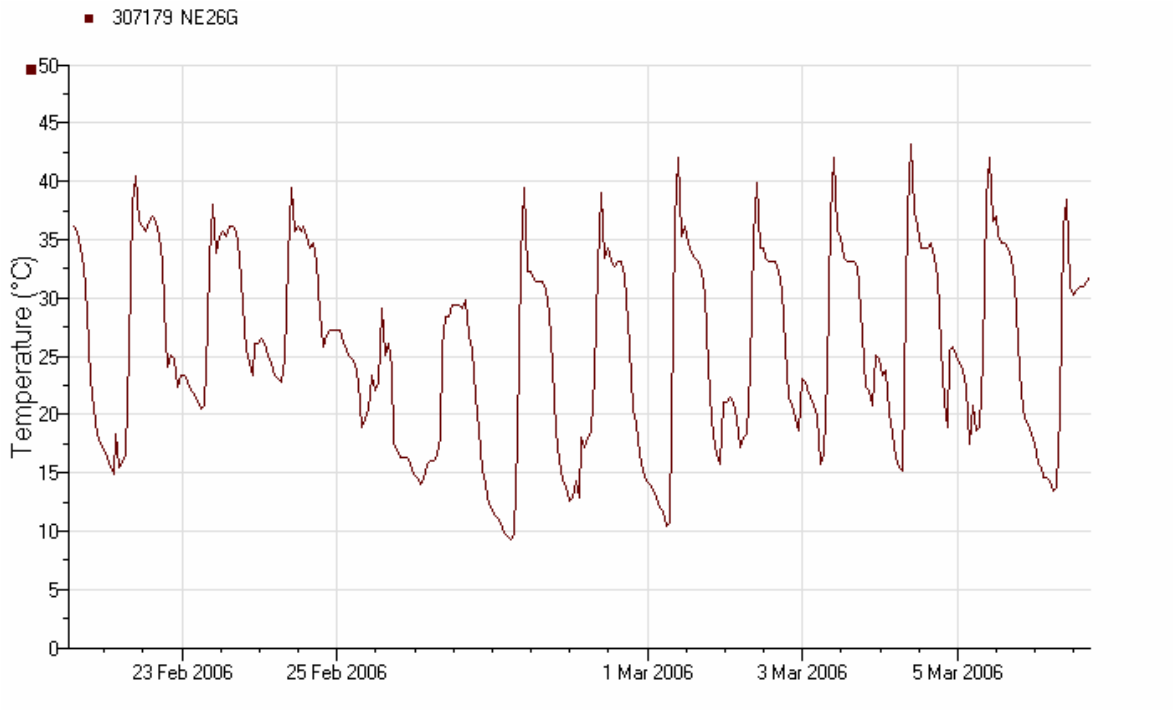


Fig. 136: 26GN Bunch zone temperature summer 06



Bunch zone temperatures vs. weather station temperatures

Fig. 137: Temperature fluctuations during the ripening phase in the shade of a Bureau of Meteorology weather station (louvred Stevenson screen in an open area) in the King Valley. Degree hours from 1. Feb to 2 Apr. = 29,780 in 61 days = average 488 day degree hours.

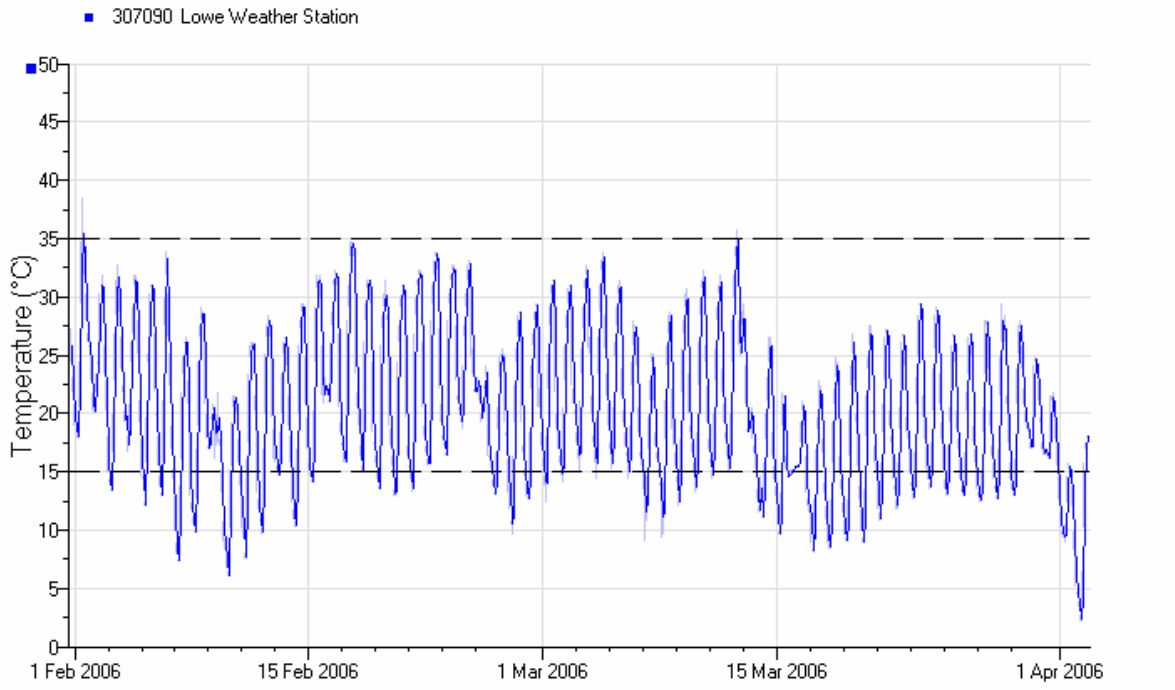


Fig. 138: Temperature fluctuations measured by a dataloggger in the bunchzone of the canopy of a vineyard 100 m away from the weather station. Night temperatures are similar, day temperatures are often 10 degrees higher due to some occasional direct sun on loggers. Here the day degree hours = 33,407 = average 548 day degree hours.

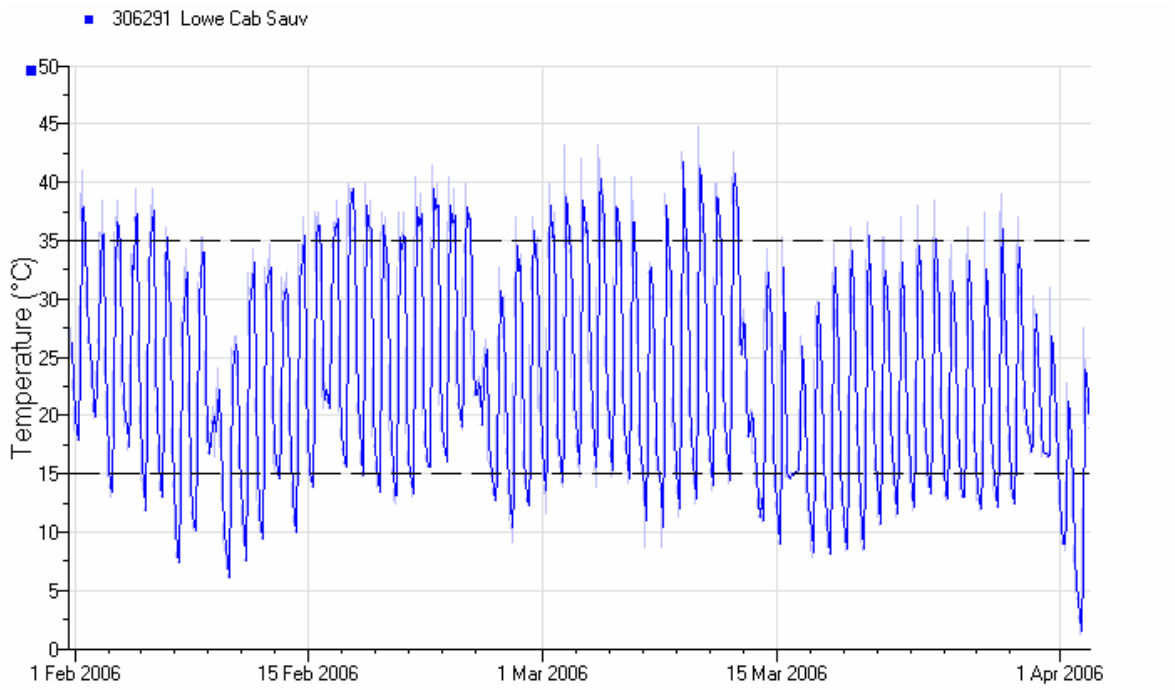


Fig. 139: Temperature fluctuations during summer inside a weather station in the King Valley. Note broad maxima at 30-35 C between 2 and 5pm.

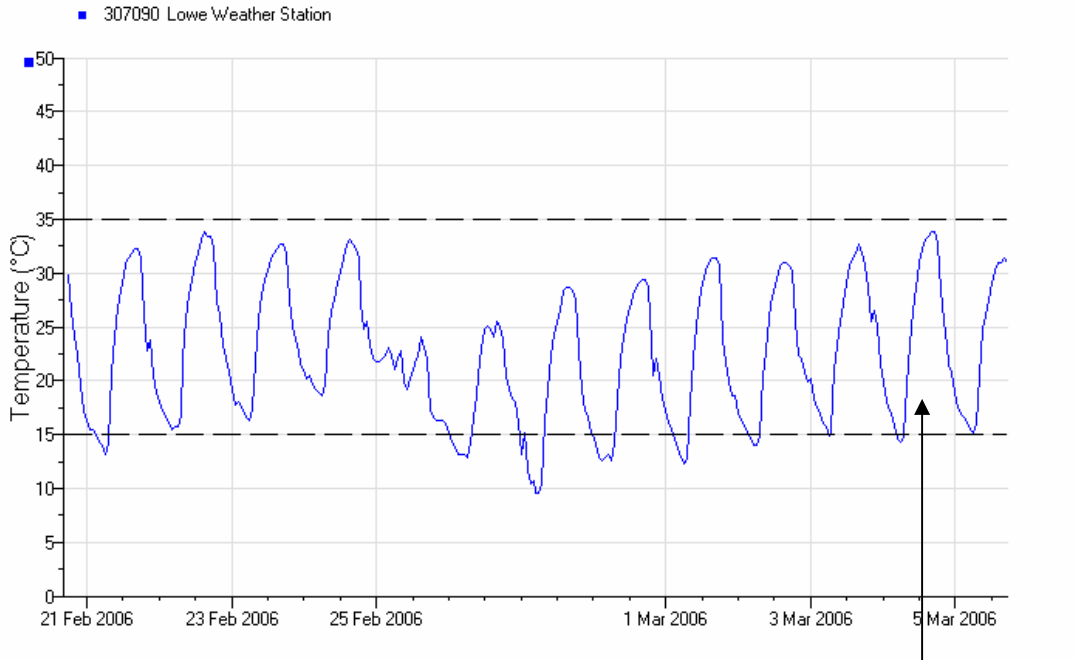


Fig. 140: Temperature fluctuations during summer inside a canopy of a vineyard 100 metres away from the weather station in the King Valley. (Bunches get hotter due to black colour and retain heat due to less air movement and a high water content)

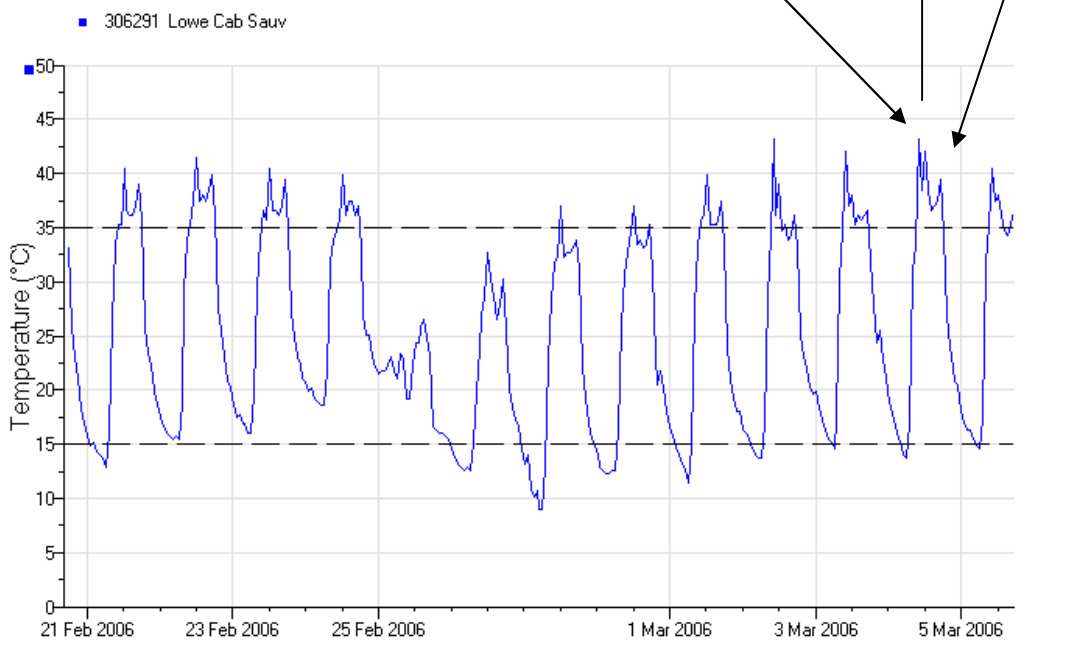


Fig. 141: The bunch zones in 06 had more hours over 35C than in 05.

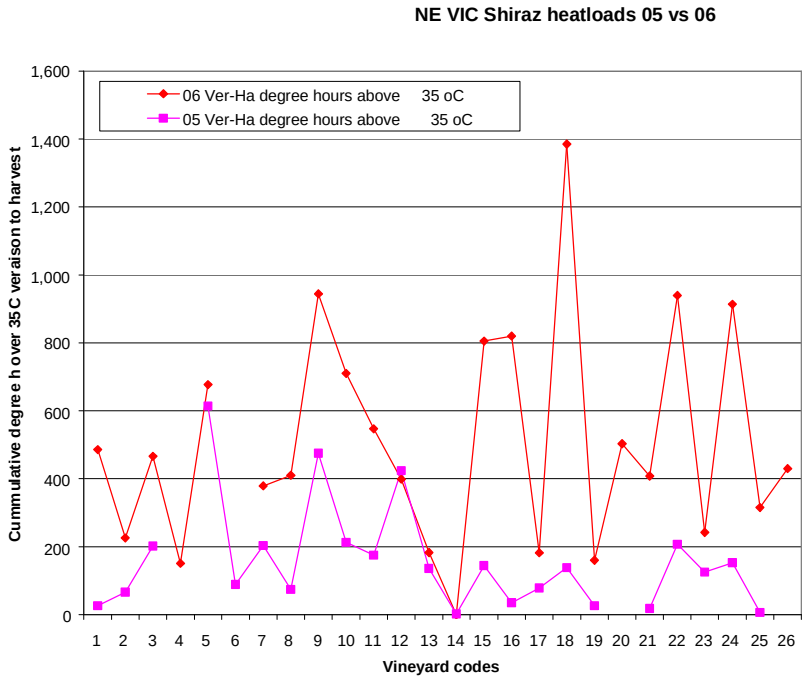


Fig. 142: The bunch zones in 06 had fewer hours below 15C than in 05

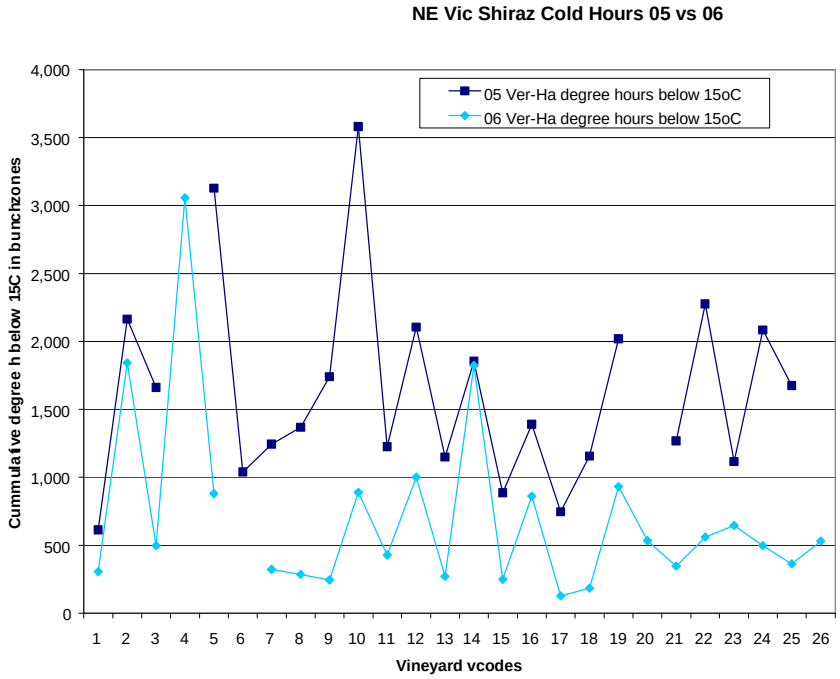


Fig. 143: Bunch zone temperature management has been practiced in many vineyards for 1 year avoiding heatloads in the hot year 06 .

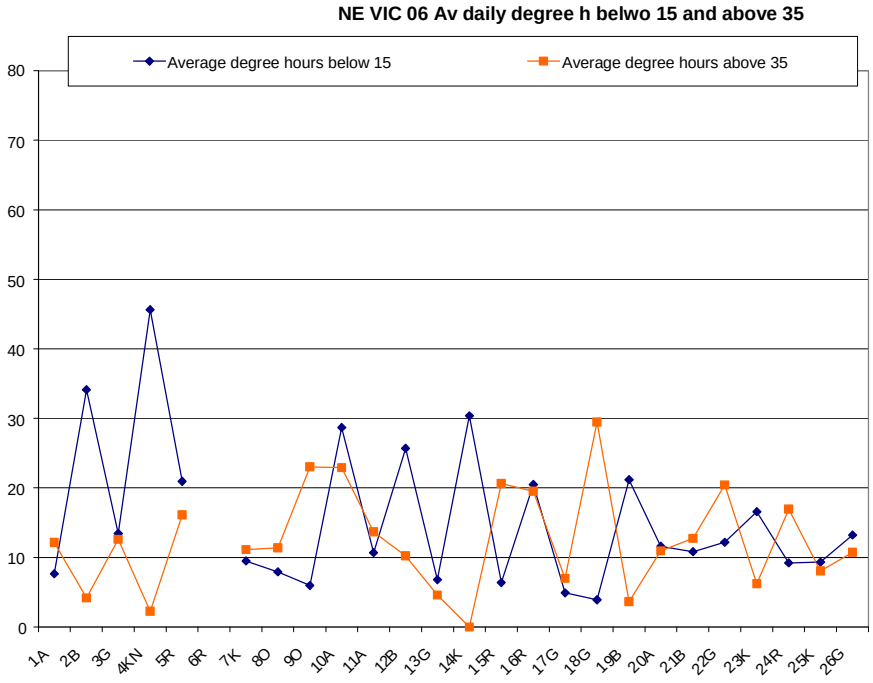
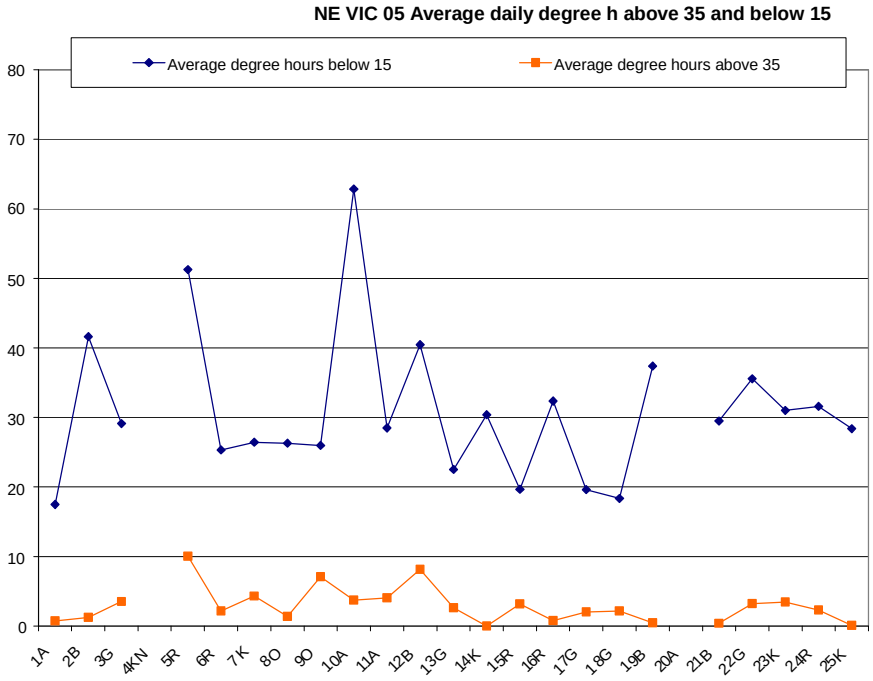


Fig. 144: NE VIC Shiraz in 05 . Upper cut-off point is 35C. Bunch zone temperature management has been practiced but few heatloads were experienced in this colder year.



Chemical analysis of berries

Baumé

Fig. 145: Bunchzone temperatures were strongly related to sugar loading. Bunchzones in heat or very cool with long hangtime loaded sugar slower than cool bunch zones. Bunches of the wines that received award wine scores last year (bold) are this year somewhat cooler at 20,000 – 25,000 degree h (except 24R and 18G). The majority of the bunches in this degree hour bracket loaded sugar at a rate of 0.32- 0.42 g/day. The value for 17G is low as the logger was installed a week post veraison missing the early season heat load data. Average veraison to harvest days =42

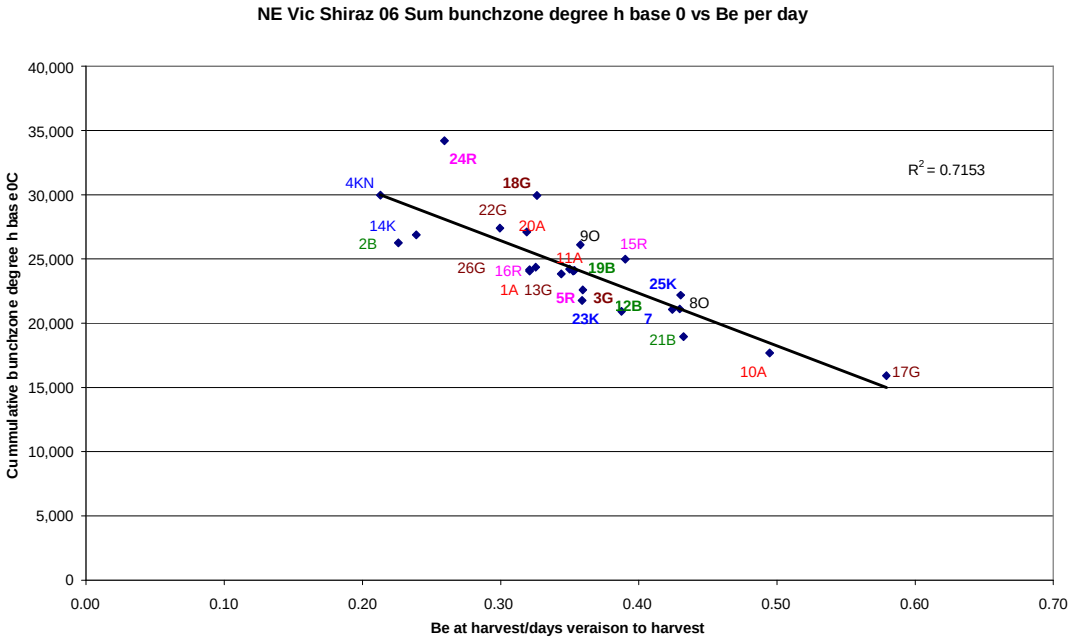


Fig. 146: In the cooler season 04/05 a similar relationship existed but the curve is steeper. Bunchzones from award winning wines were found in the 23,000 – 30,000 degree hour bracket and sugar loading for these bunches was slower than in the 06 season with 0.22- 0.32 g/day. Average veraison to harvest days =52

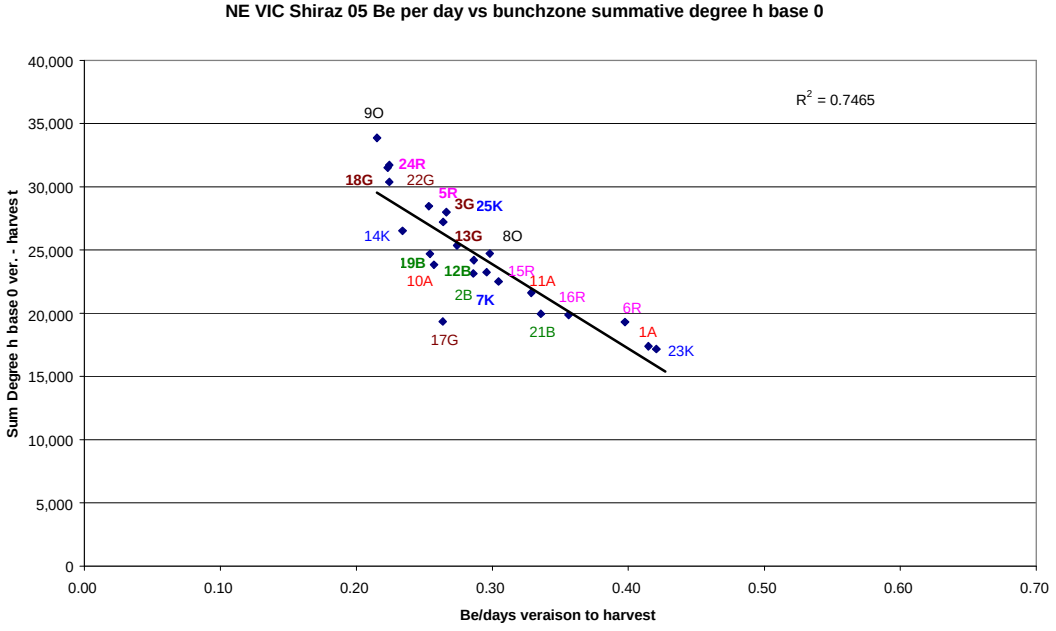


Fig. 147: When the calculations were performed adding degree hours above 15C the image is very similar showing that the nights did not have much influence.

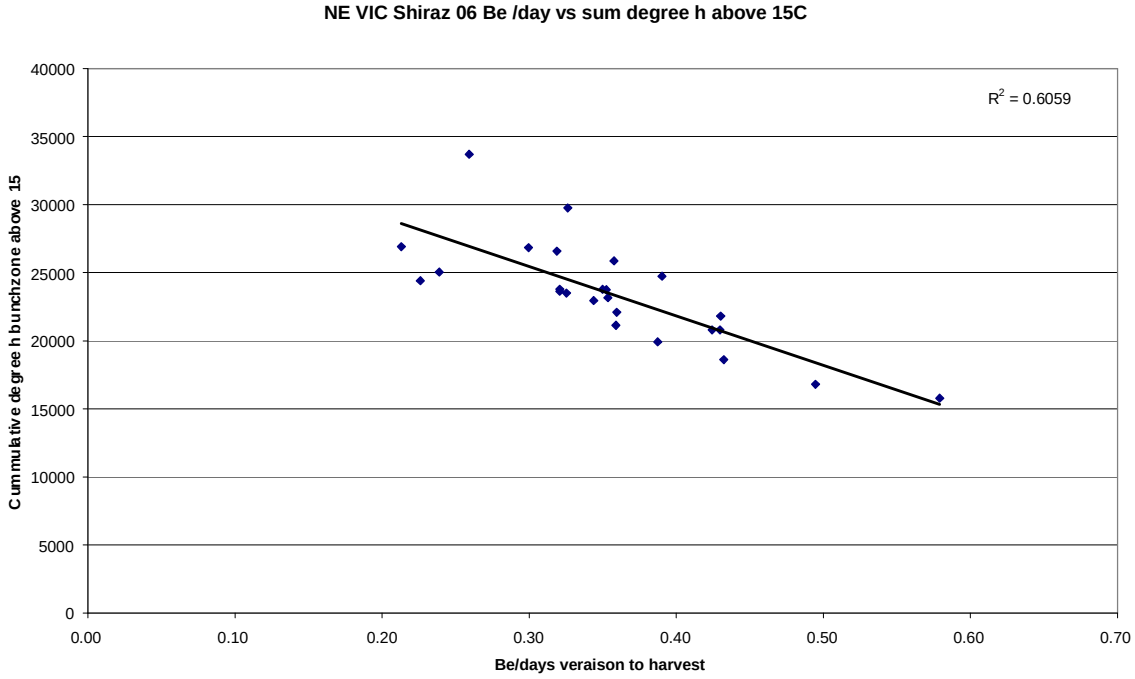


Fig. 148: When the degree hours of the optimum temperature span (15-35C) was calculated ten vineyards with heat loads changed their positions (eg 9O, 15R, 18G, 22g, 24R) but also those with cold nights (2B, 4K, 14K). It is an unrealistic calculation and does not reflect the true ripening phase of bunches deleting the extremes.

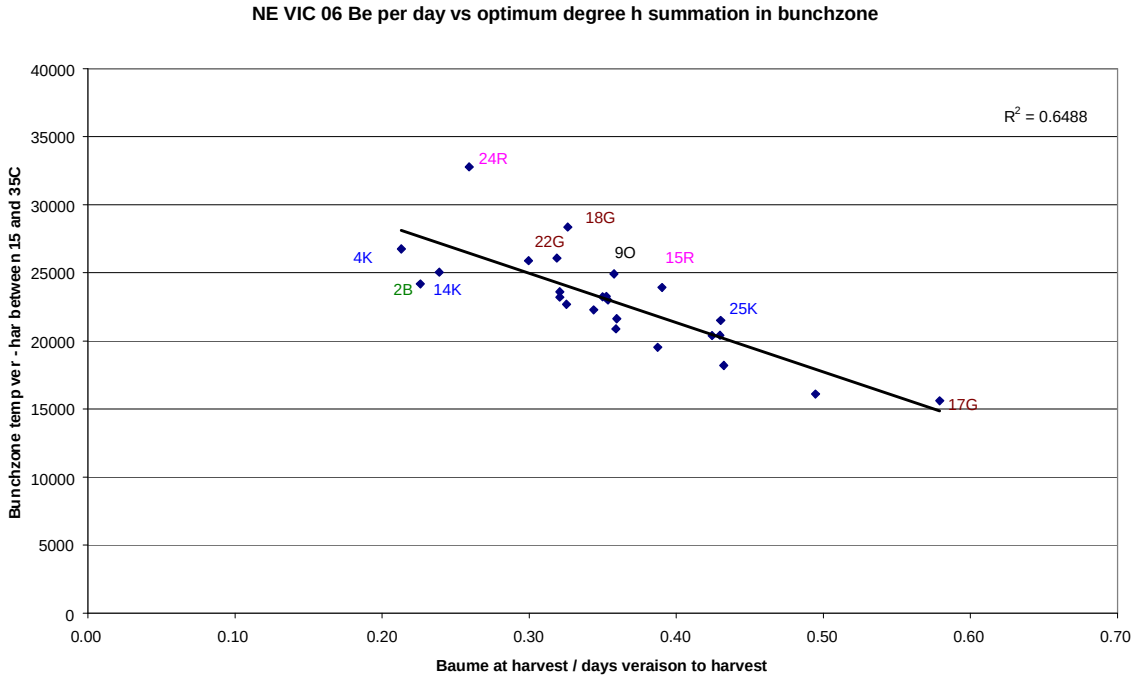


Fig. 149: Baumé at harvest did not depend on weight of fruit on an average shoot because the whole vine matters for sugar loading (eg number of leaves, shade or light on leaves etc.)

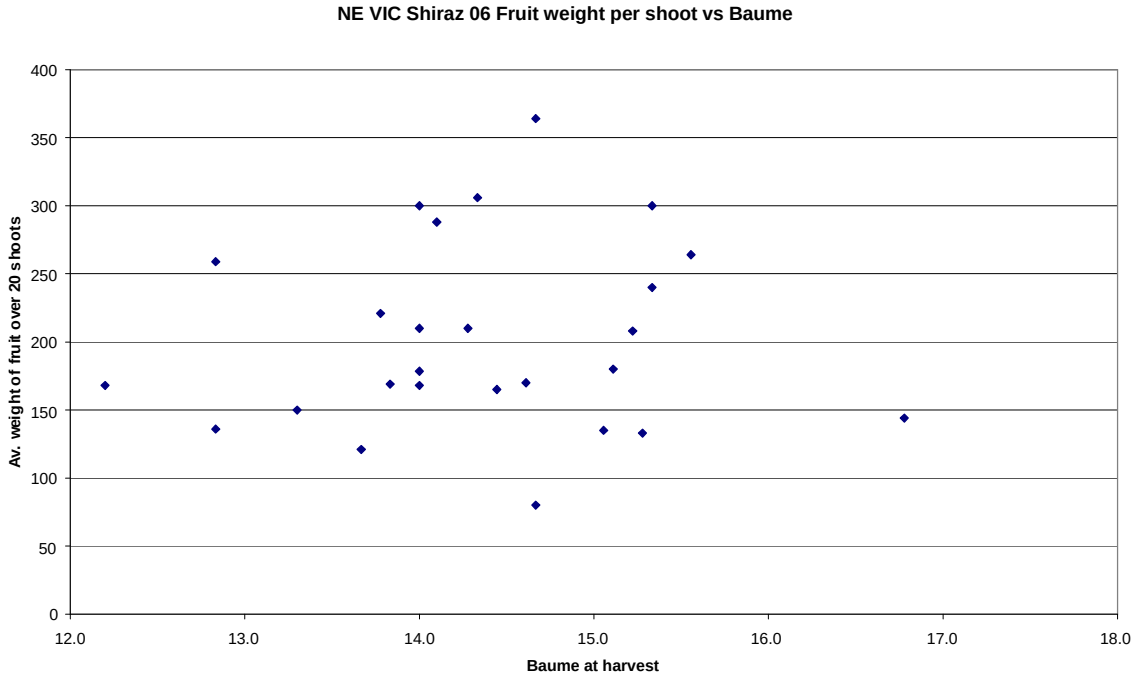
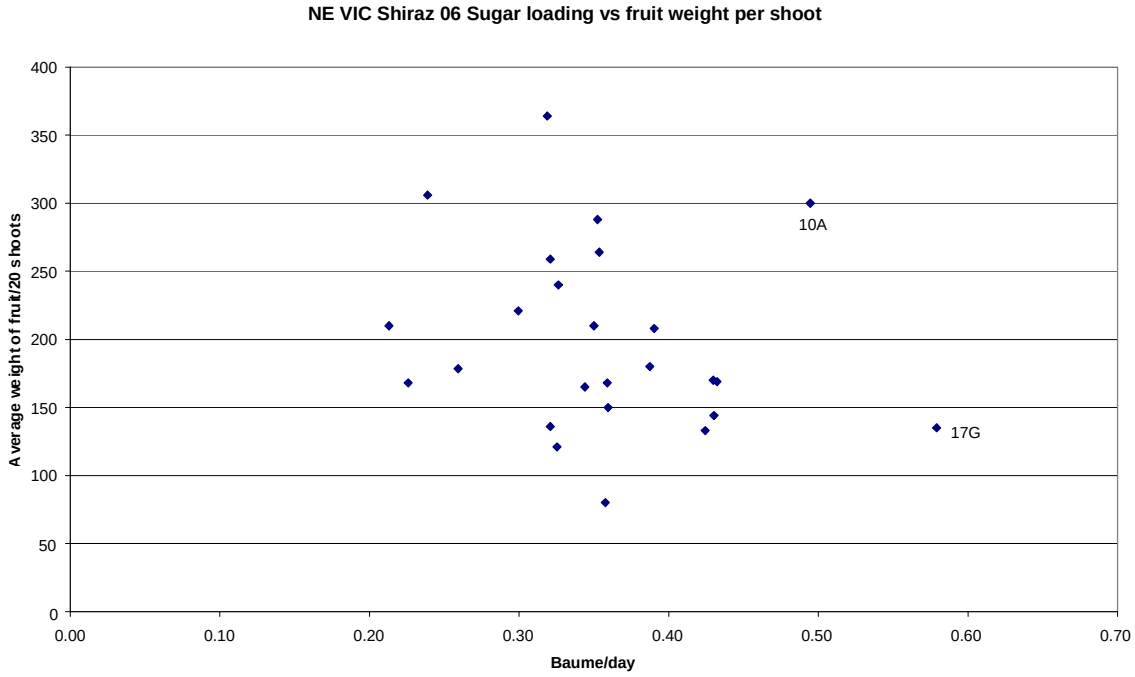


Fig. 150: Sugar loading per day was independent of weight of fruit on an average shoot, but depended on degree hour summation (see Fig. 120) which is a function of location, canopy management and hangtime.



TA

Fig 151: Acid retention is low (depletion faster, thus lower ratio acid to days) under high bunchzone temperature summations and high in cooler bunches.

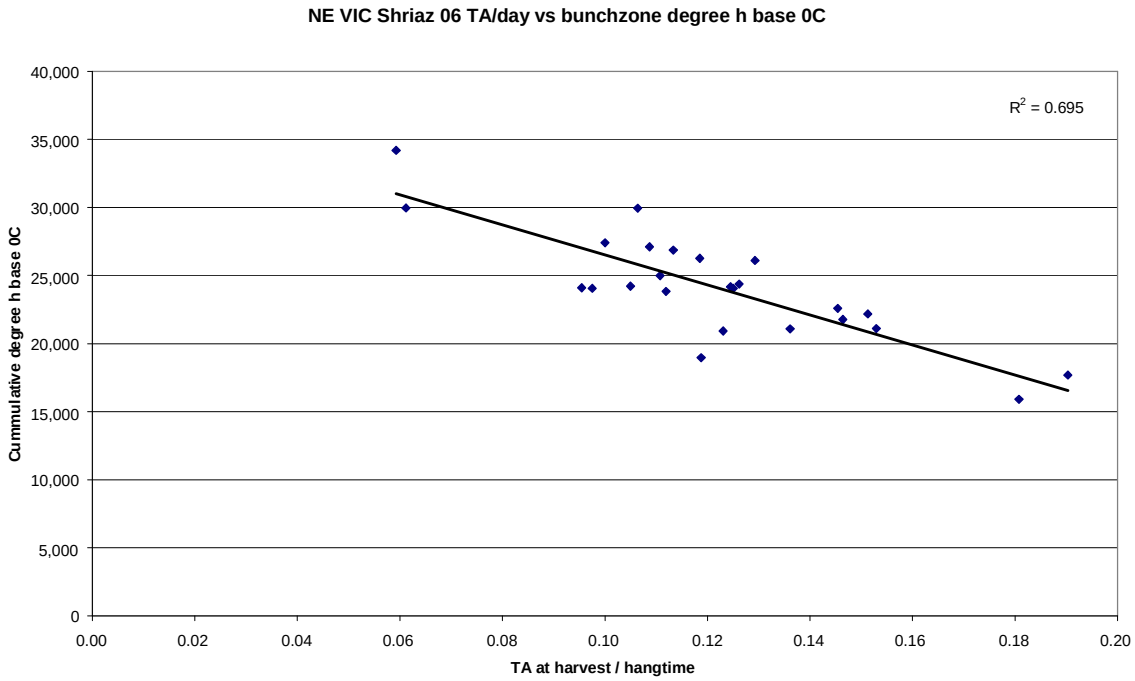


Fig. 152: The same relationship existed, albeit weaker, in the cooler year of 04/05.

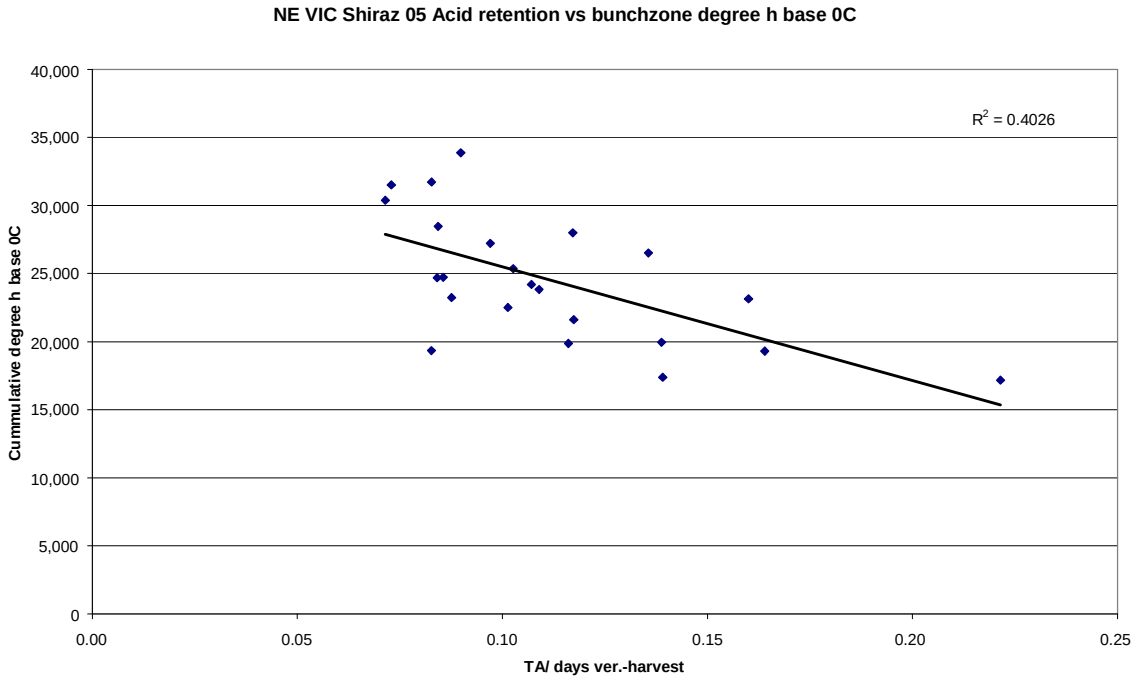


Fig. 153: Acid retention is correlated to vine balance, more acid is retained per unit of time when leaf area to fruit weight is higher. (17G missed first week, 7K and 10A short hangtime, 24R long hangtime)

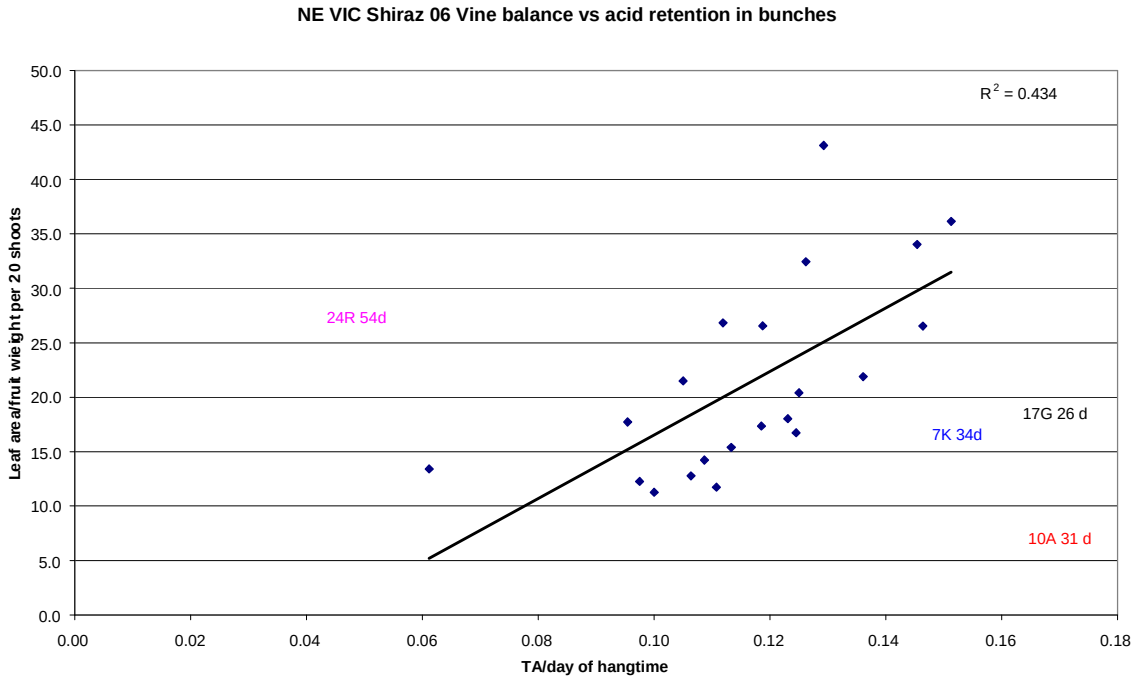
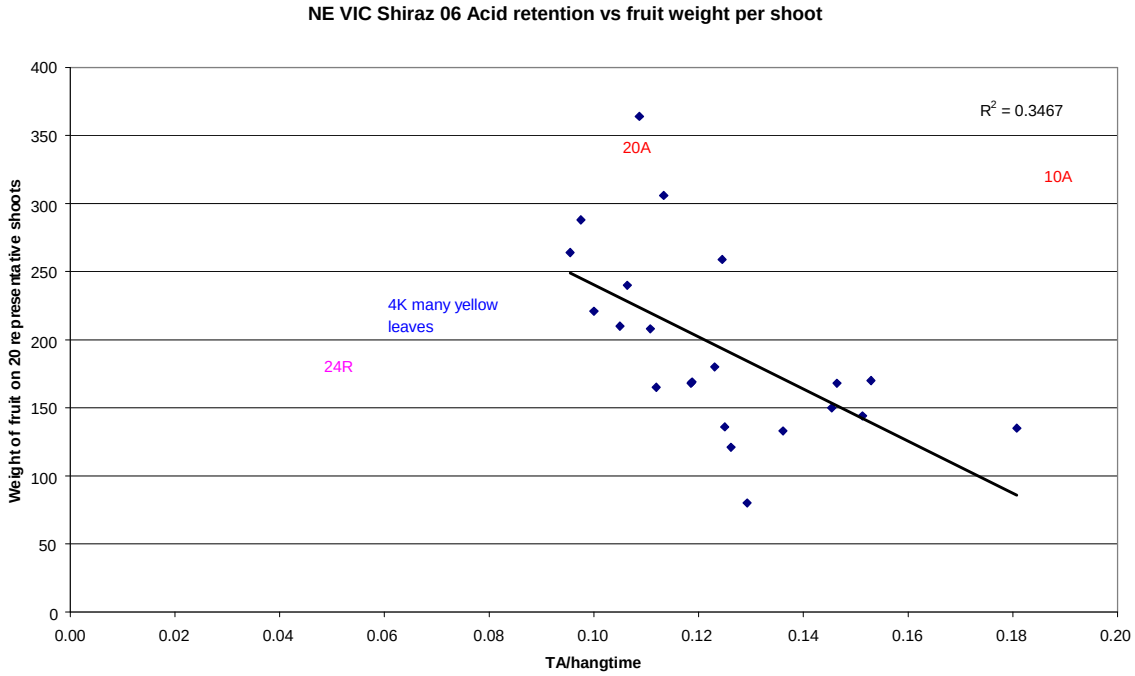


Fig. 154: TA retention is not caused by average leaf area per shoot, there was no relationship, the important determinate in vine balance with respect to acid retention is fruit weight per shoot. Bunches from shoots with more fruit weight lose acid faster, often due to longer time of ripening required and non linear relationship between acid loss and hangtime.



Colour

A quality trait that is of interest for the winemakers is the colour potential of grapes for the resulting wine. Colour formation has, in the literature been proven to be negatively affected by overcropping, poor nutritional status and drought. NE VIC vineyards are generally well managed and vines should not have excessive deficiencies. Since the late 1990's it has been proven that colour formation is very much influenced by heat (Tarara et al). Thus it was of interest to investigate the effect of bunchzone temperatures on colour at harvest.

Fig. 155: There is only a slight trend that bunches with higher heat summation (heat and hangtime) have lower colour values.

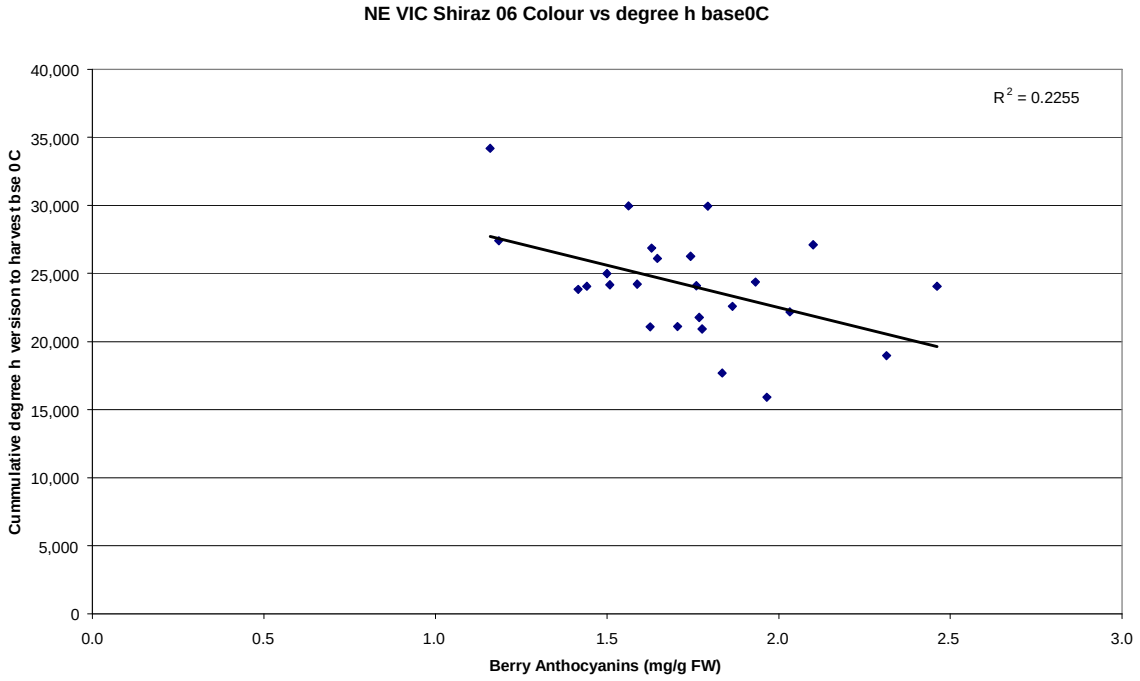


Fig. 156: This trend was even less expressed in the cooler year 04/05

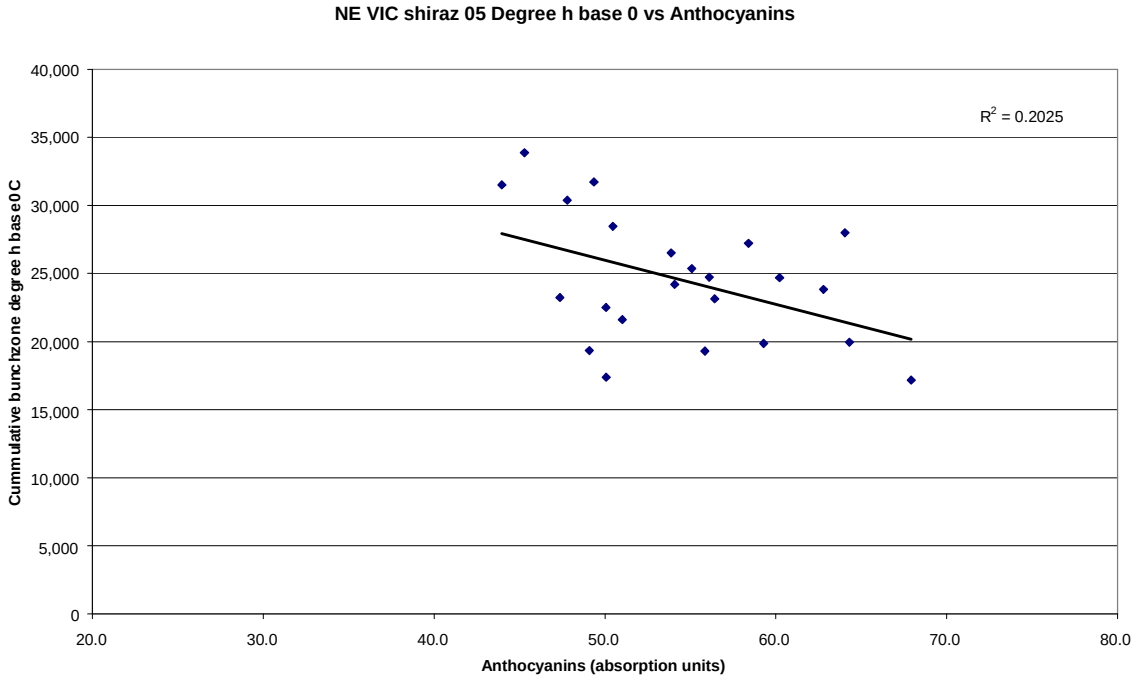


Fig. 157: High colour berries have fewer hours of heat loads above 35C and low colour berries high heat loads but in-between there is a range of heat summations for any colour value.

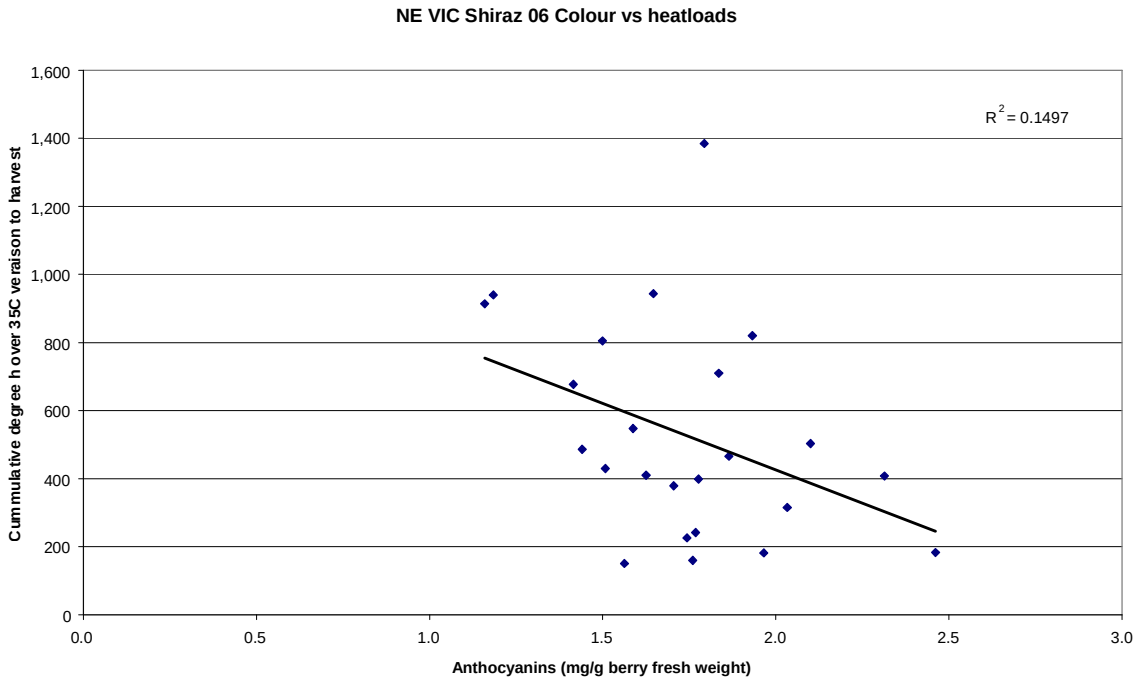


Fig. 158: This trend was less expressed in the cooler year 04/05 as there were very few heatloads

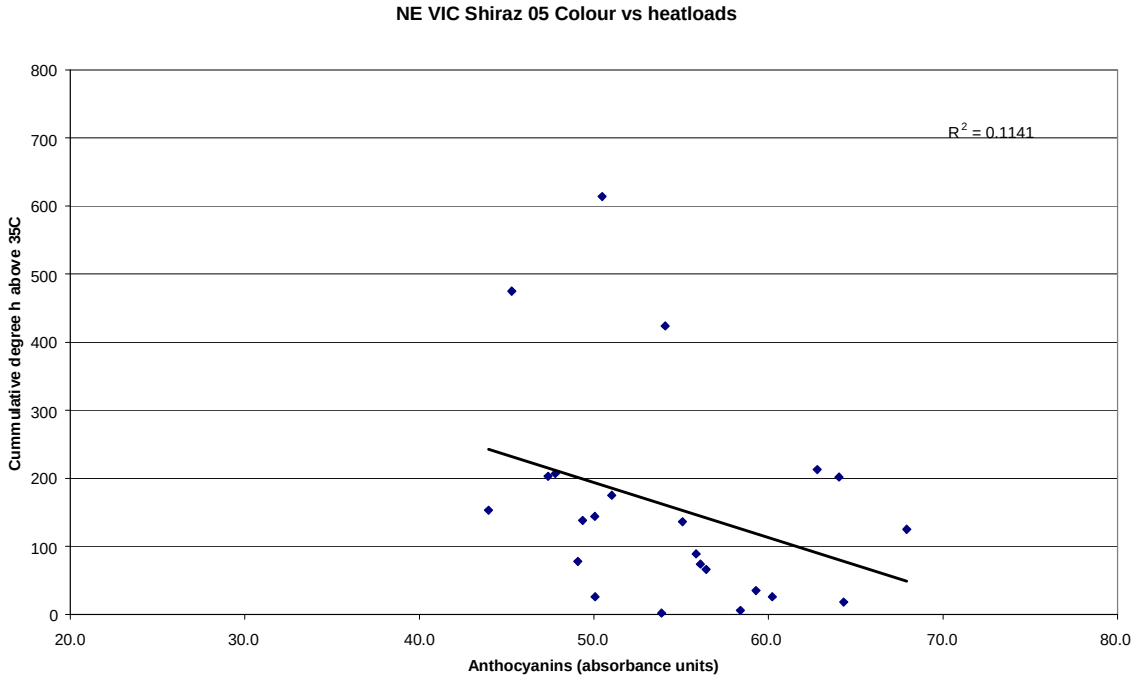


Fig. 159: Hang time did not have a significant effect on colour. It matters in what conditions (temperature, fruit load, water etc.) the bunches hang.

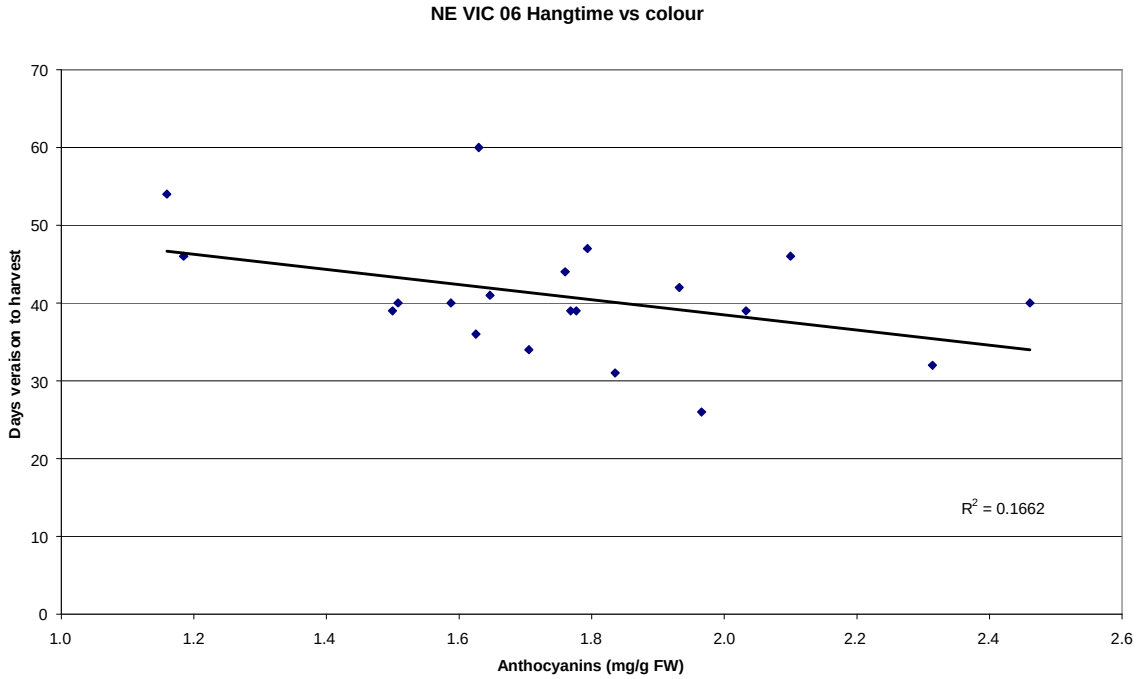


Fig. 160: Weight of berries is not a determining factor in the middle colour range. Last season many berries were bigger due to late rain, and when they had a high proportion of skin their greater weight did not matter. Thin-skinned berries with high water content of course show diluted colour. This year skin proportions were not measured.

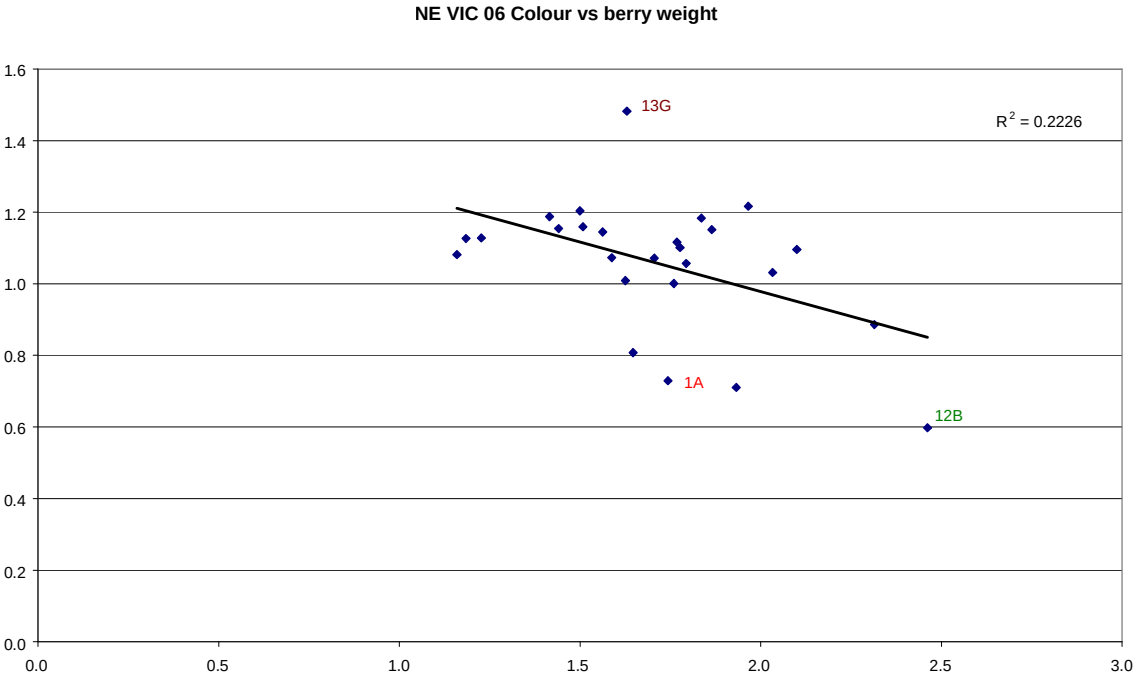


Fig. 161: A lower weight of fruit per shoot (thinning) did not always increase colour but some vineyards which won high scores for their wines last year are this year in the lower fruit load bracket.

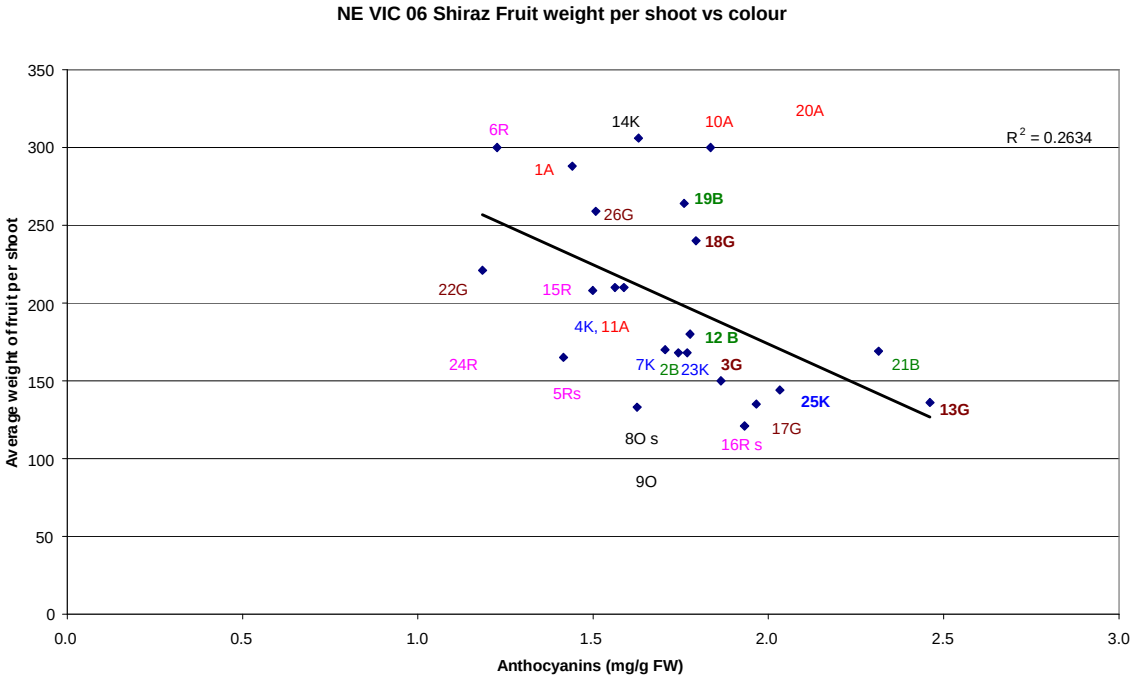


Fig. 162: When the shrivelled berries were taken out of statistics, this relationship became stronger, but not significant. Better colour in low bunch loads per shoot may have been due to shorter hangtimes (and less colour loss) or more resources to make colour.

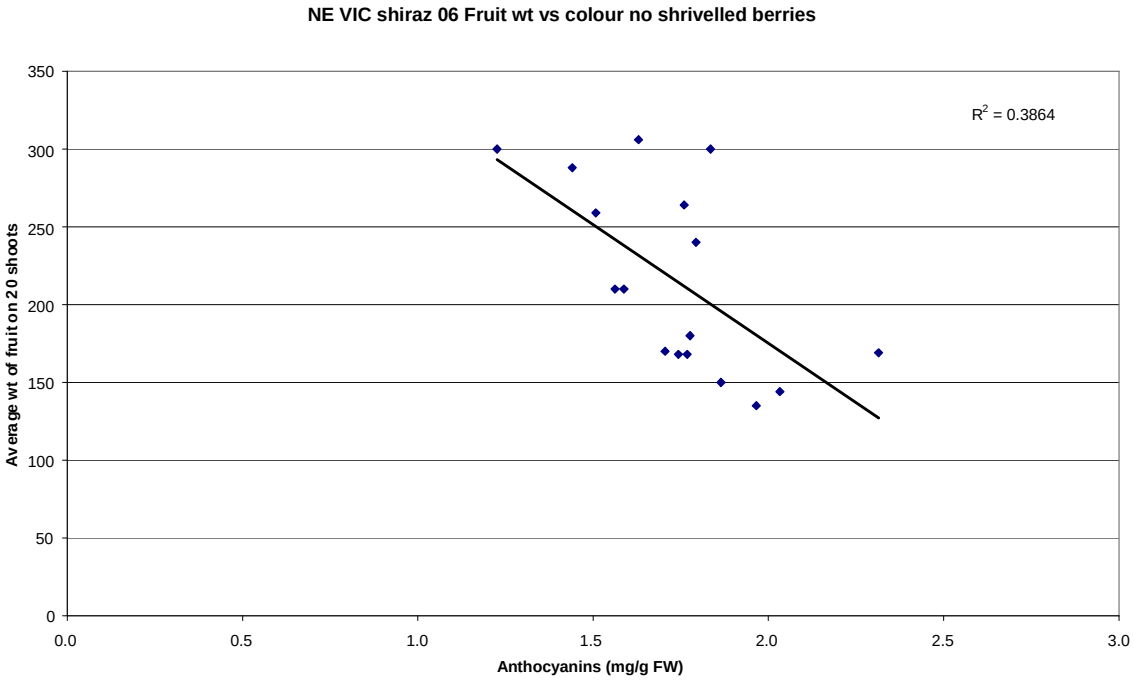


Fig. 163: In the milder season of 04/05 lower average bunch weights per shoot did not have an effect on colour.

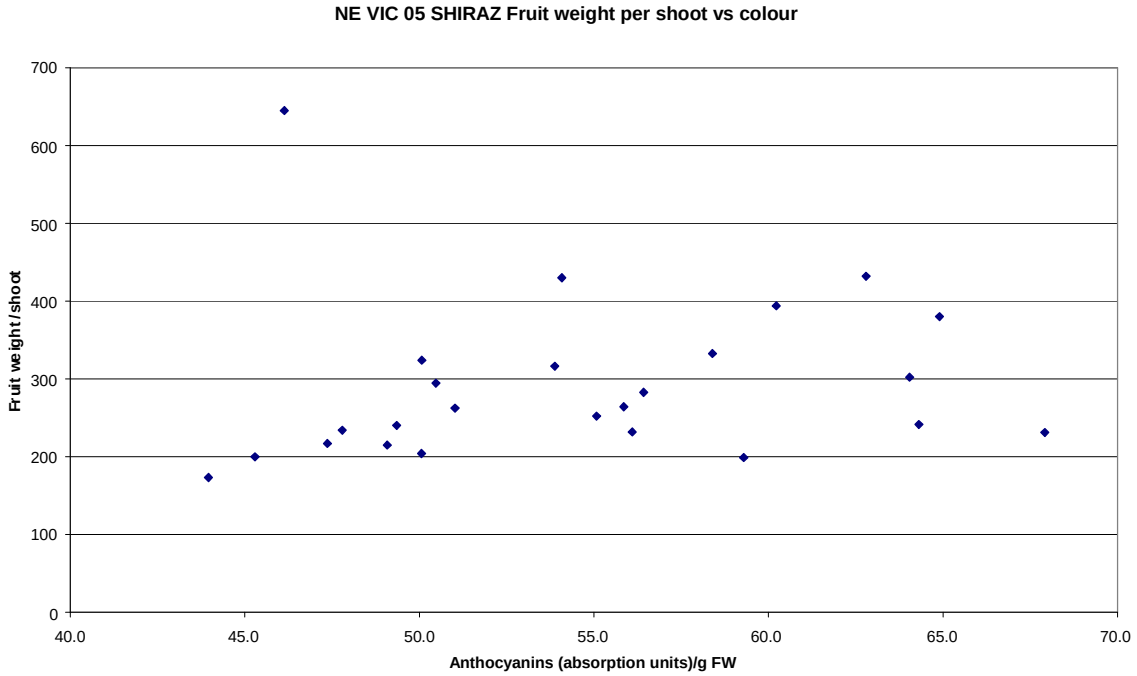


Fig. 164: Vine balance did not have a significant effect on colour as it was out of balance (high values) due to low fruit weights vs. leaf areas. It could have mattered if the values had been lower than usual. (High fruit weight vs. leaf area)

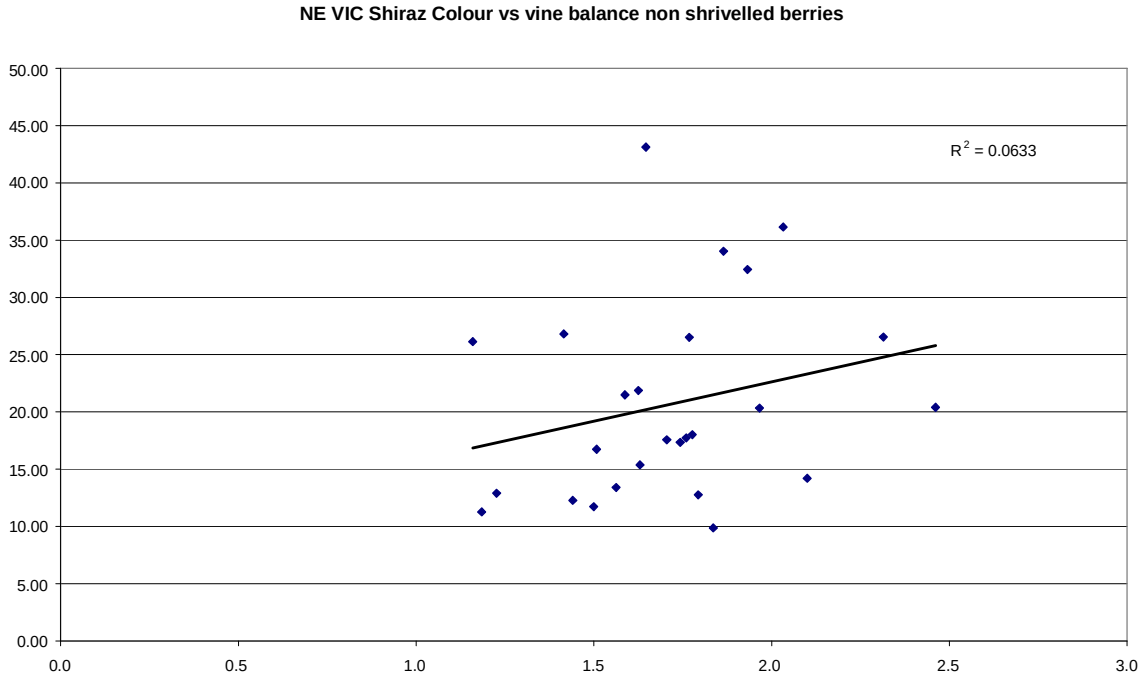


Fig. 165: Berries that were positioned in higher leaf cover on the east or south side (morning sun) had a lower colour (15 and 10 % shrivelled berries excluded).

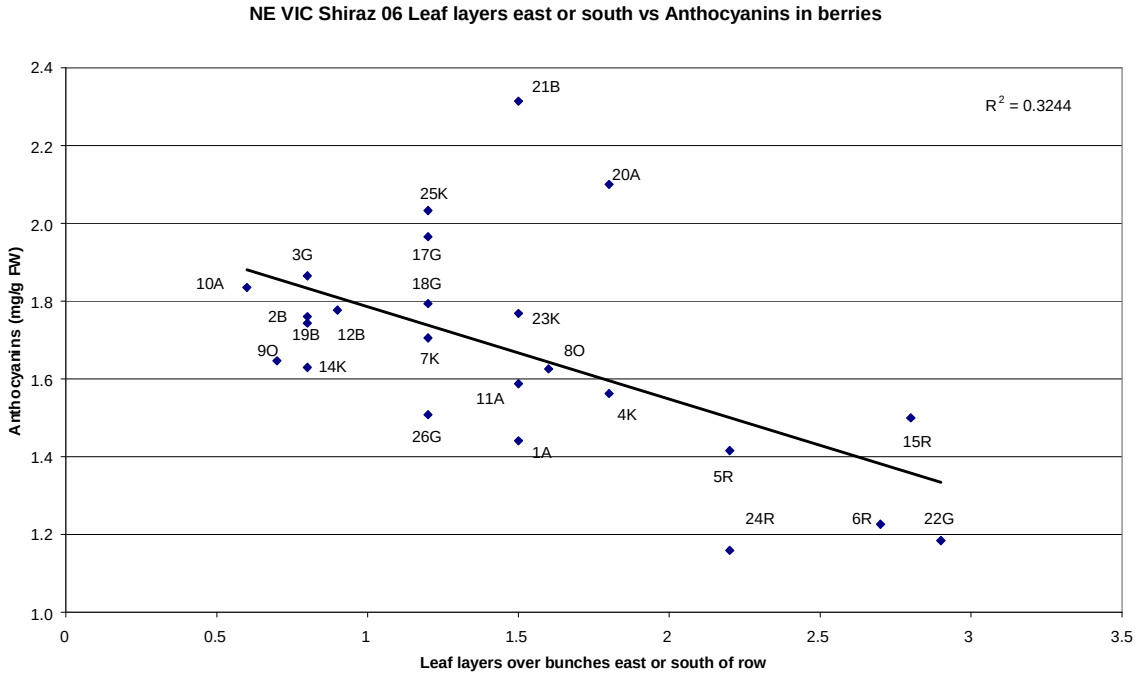


Fig. 166: Leaf cover on the west side had no distinct effect except open canopies in cold locations seemed to be beneficial. Hangtime is crucial for canopy studies.

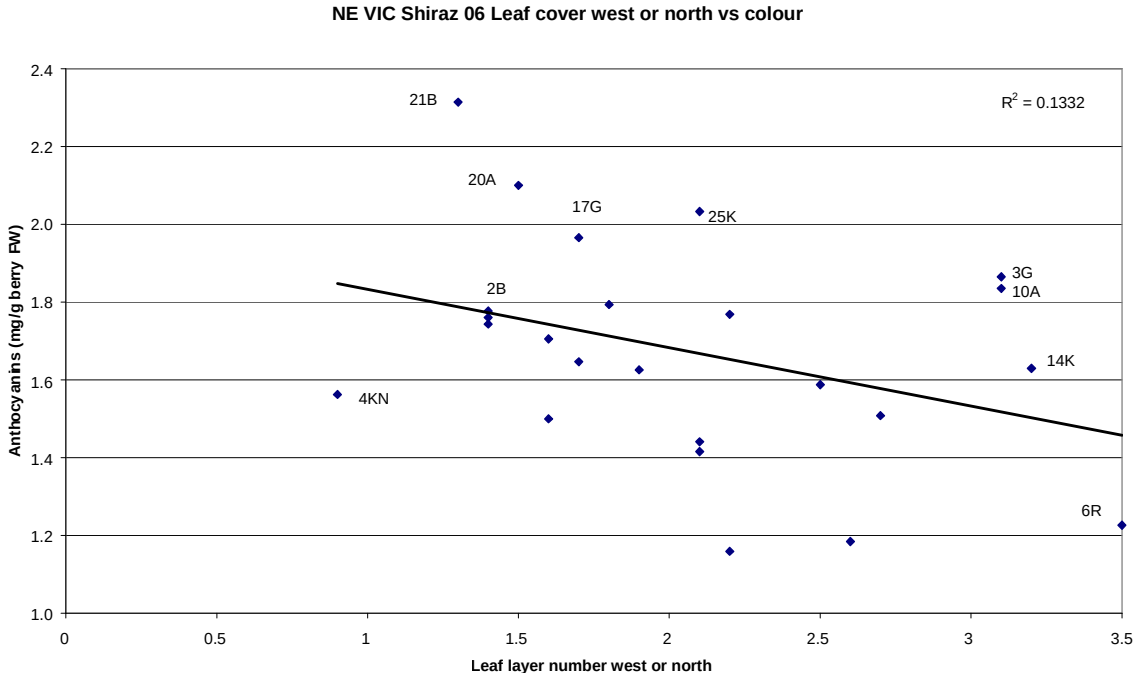


Fig. 167: When average front and back leaf cover was calculated, the relationship became more distinct in the extremes, shaded bunches produce less colour, but less clear in the 1-2 leaf layer sector.

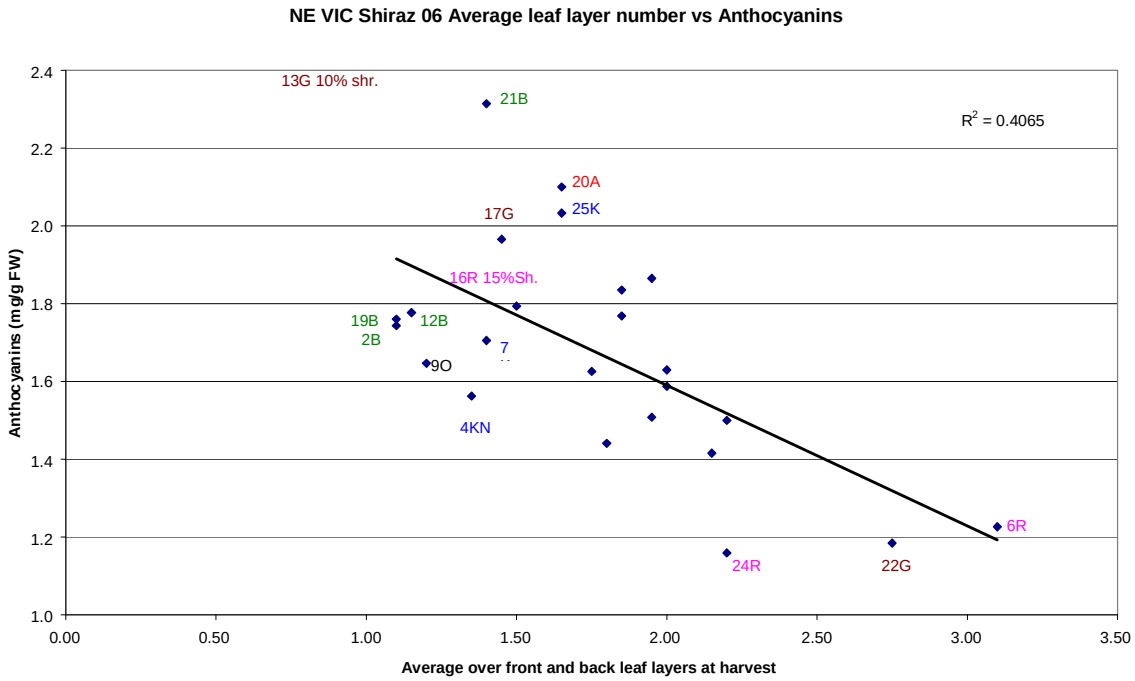


Fig. 168: Retaining leaves on the north and west side (more sun exposed) brings hotter vineyards more into the physiological temperature range.

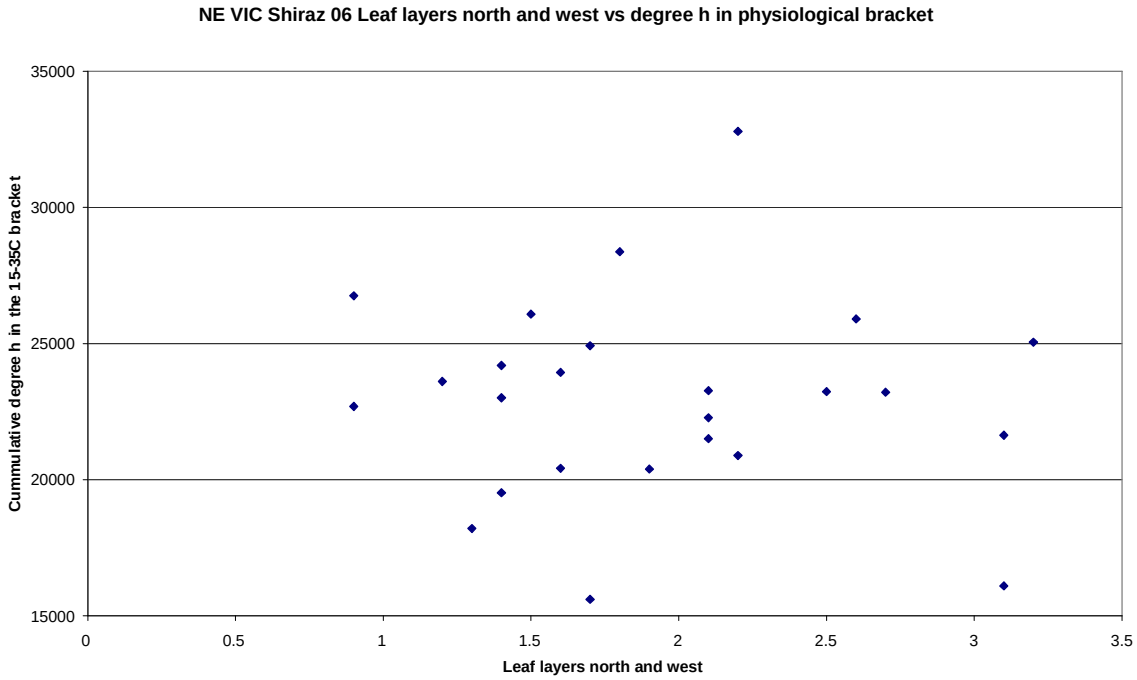


Fig. 169: Plucking leaves on the east and south side (less sun exposed) can bring cooler vineyards more into the physiological temperature range (except 10A – short hangtime, 21B short hangtime, 12B- cold nights, 17 G – short hangtime) 24 R with long hangtime has accumulated many warmth hours despite higher leaf cover east.

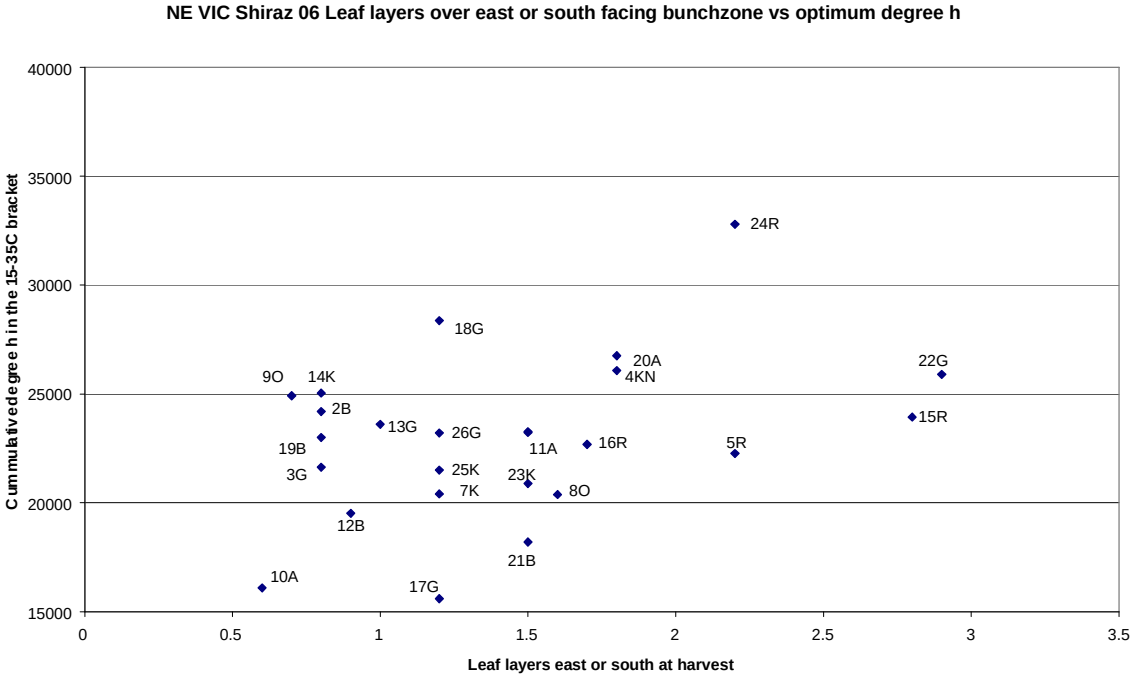


Fig. 170: The speed of colour formation depends on the average degree hours in the bunchzone and exposure time. Bunches with long cold and long hot hang times had low colour production per day of hangtime. Bunches with short hang times in beneficial conditions had best colour formation (less loss through extended hang times?). Bunches in too hot average temperatures had slower colour formation even with average hang times. Shrivelled berries excluded.

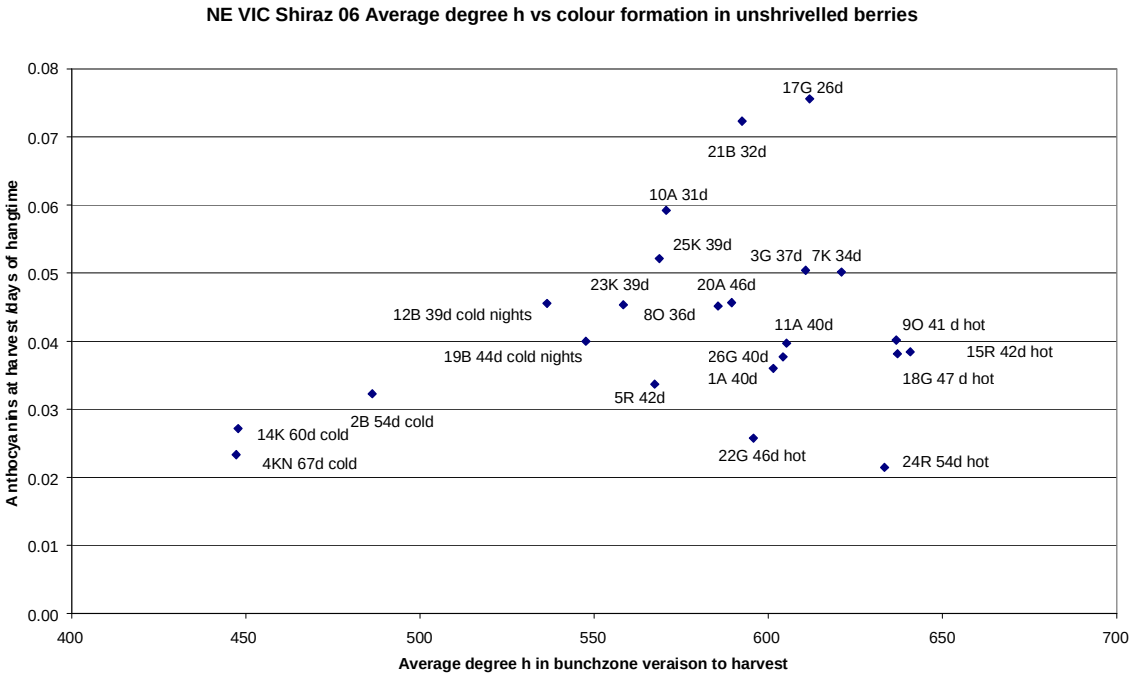


Fig. 171: When shrivelled berries were excluded, colour at harvest was correlated with TA. Maybe short hangtime was beneficial to colour and acid retention.

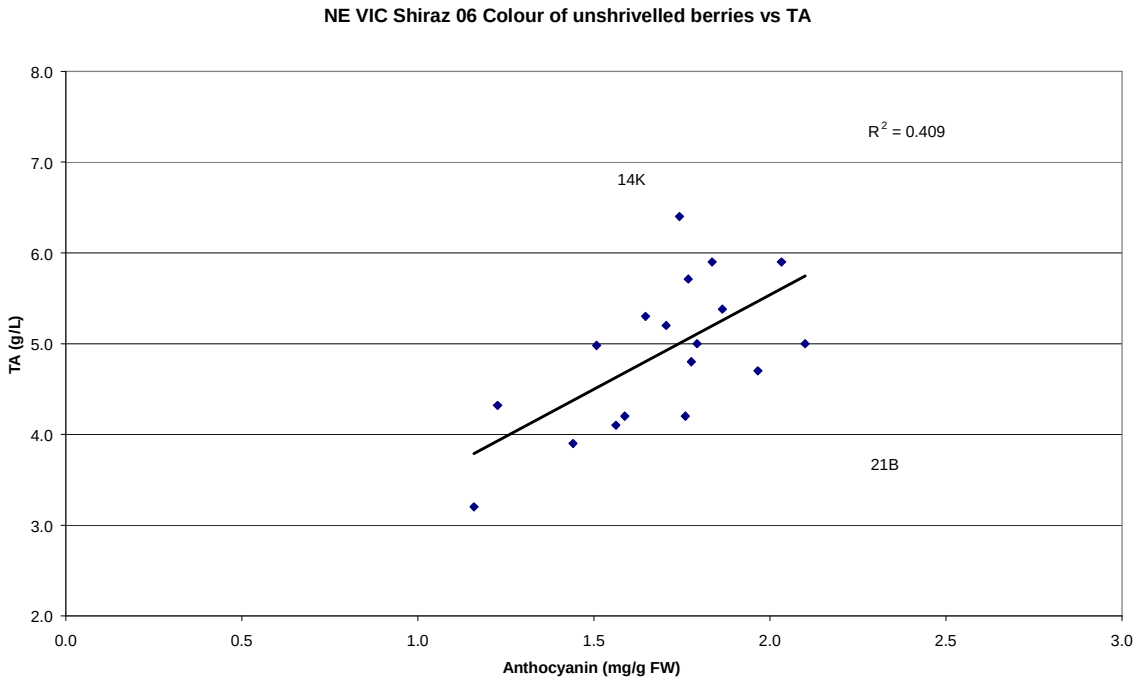
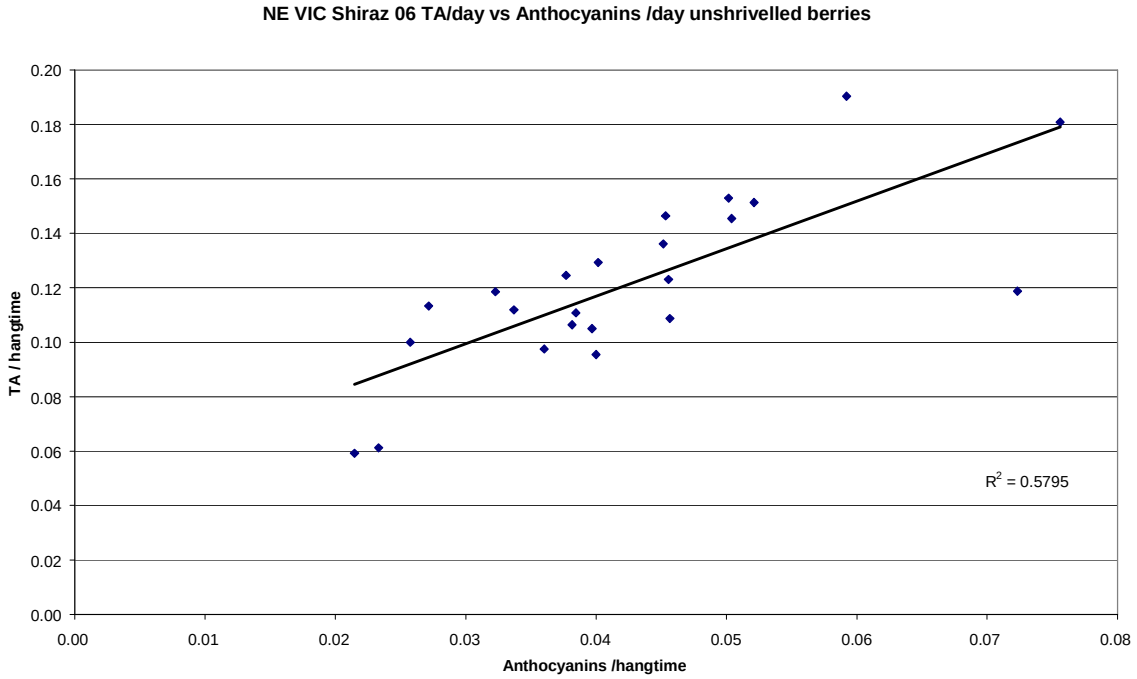


Fig 172: Acid retention per day is a good indicator of colour potential in unshrivelled berries



Total Phenolics

Fig. 173: High phenolics at harvest do not correlate with high Baumé at harvest.

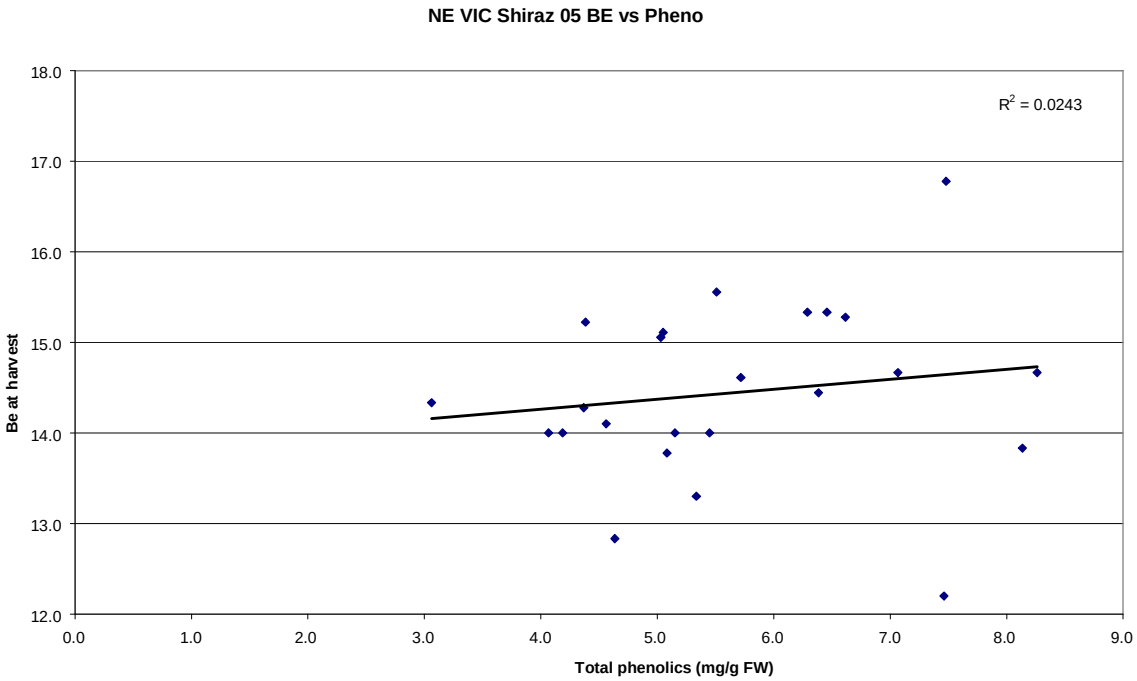


Fig. 174: High phenolics at harvest only slightly correlate with high TA at harvest.

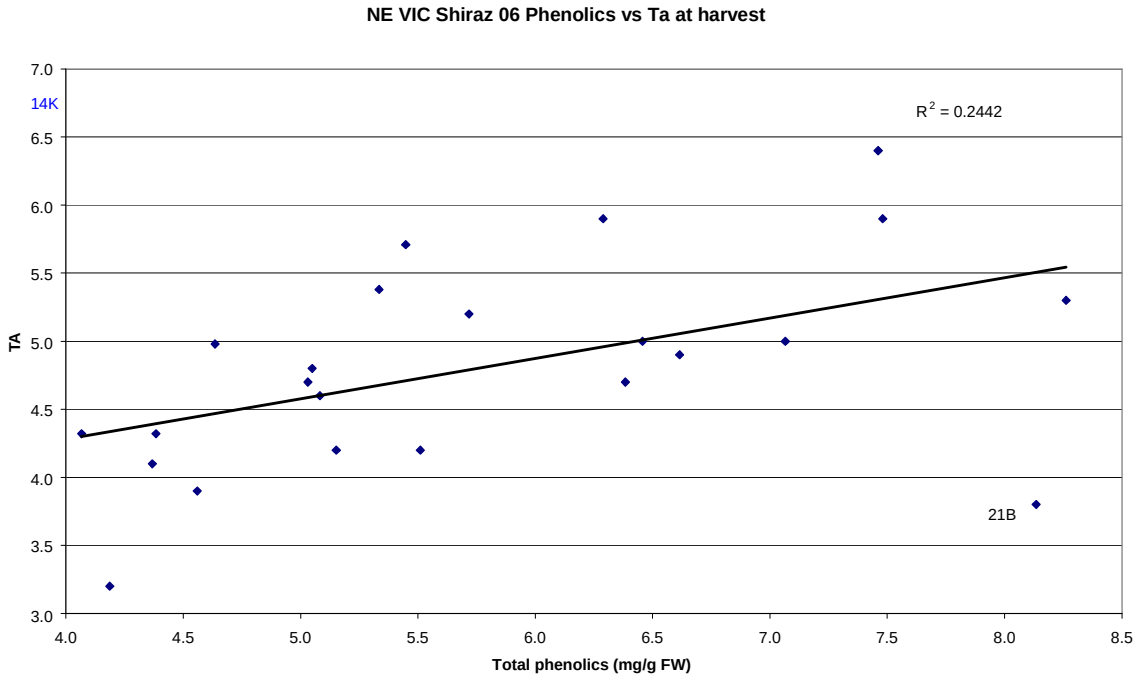


Fig. 175: To study the correlation of physiological processes their dynamics must be compared. The speed of phenolic ripening (caution, here skins and seeds are ground up and unripe seeds produce more phenolics that ripe seeds, the opposite is true for skins!) is related to the speed of sugar accumulation. Berries with more than 10% shrivel excluded from statistics.

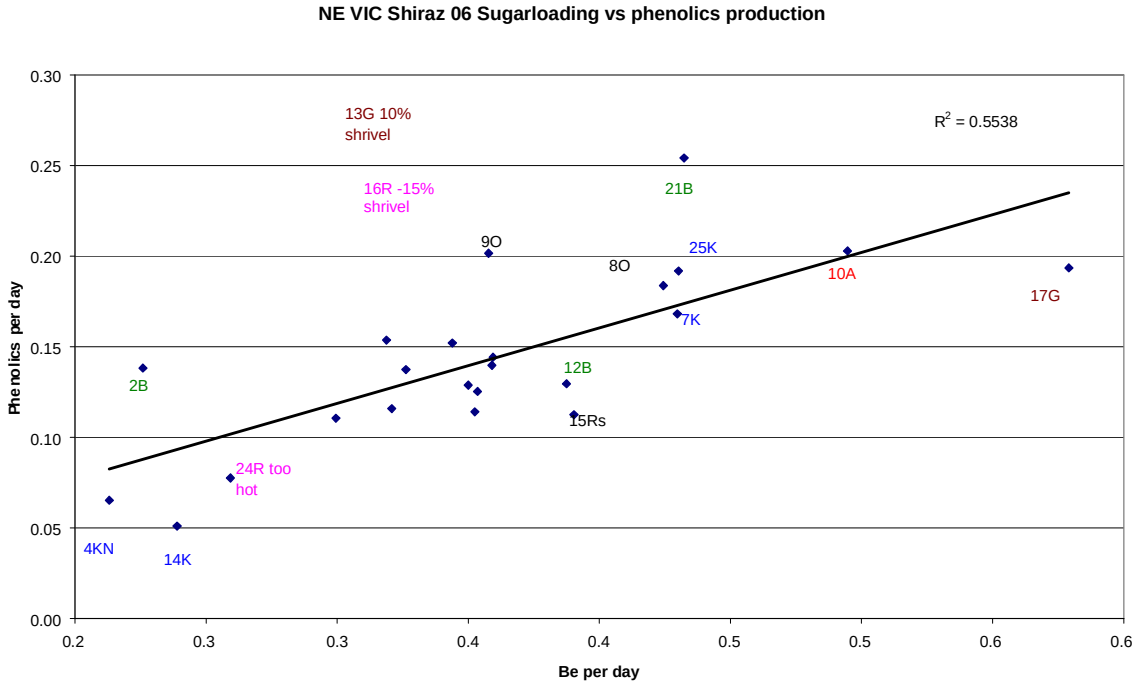


Fig. 176: This was also the case in 2005 and more accentuated as the phenolics only derived from the skins.

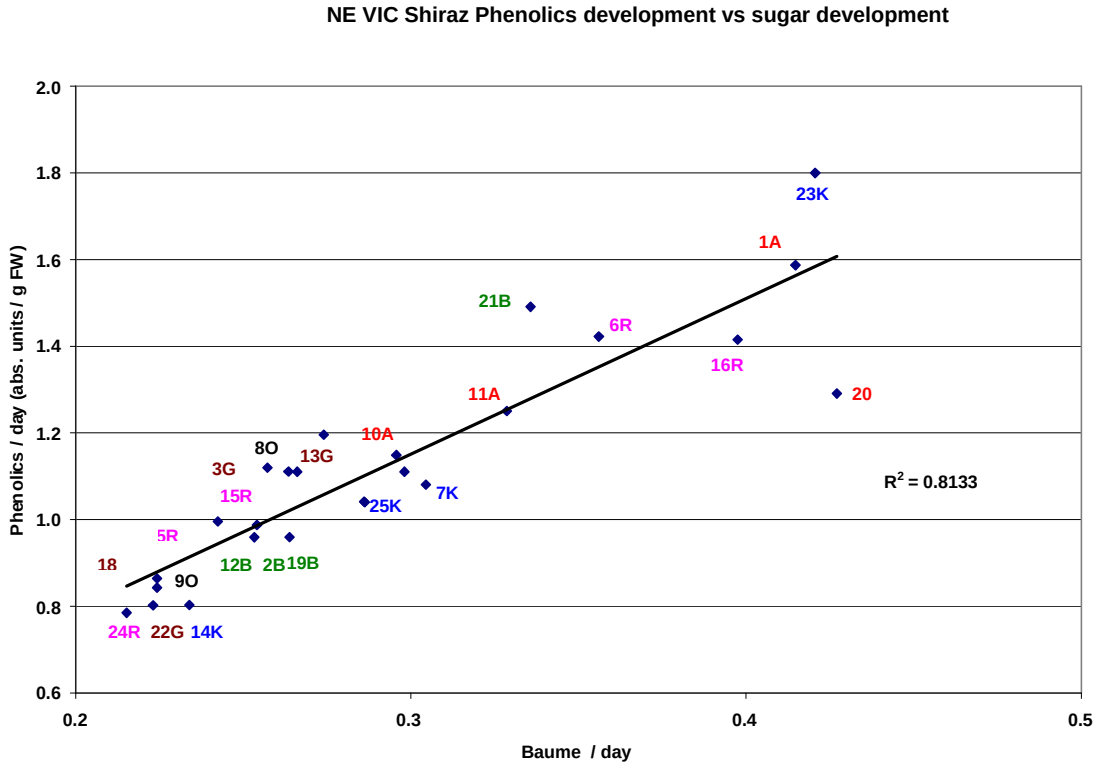


Fig. 177: Berries with fast acid loss (left hand bottom, high heat loads and or long hangtime) had fewer total phenolics per day of hangtime. Berries with more than 10% shrivel excluded.

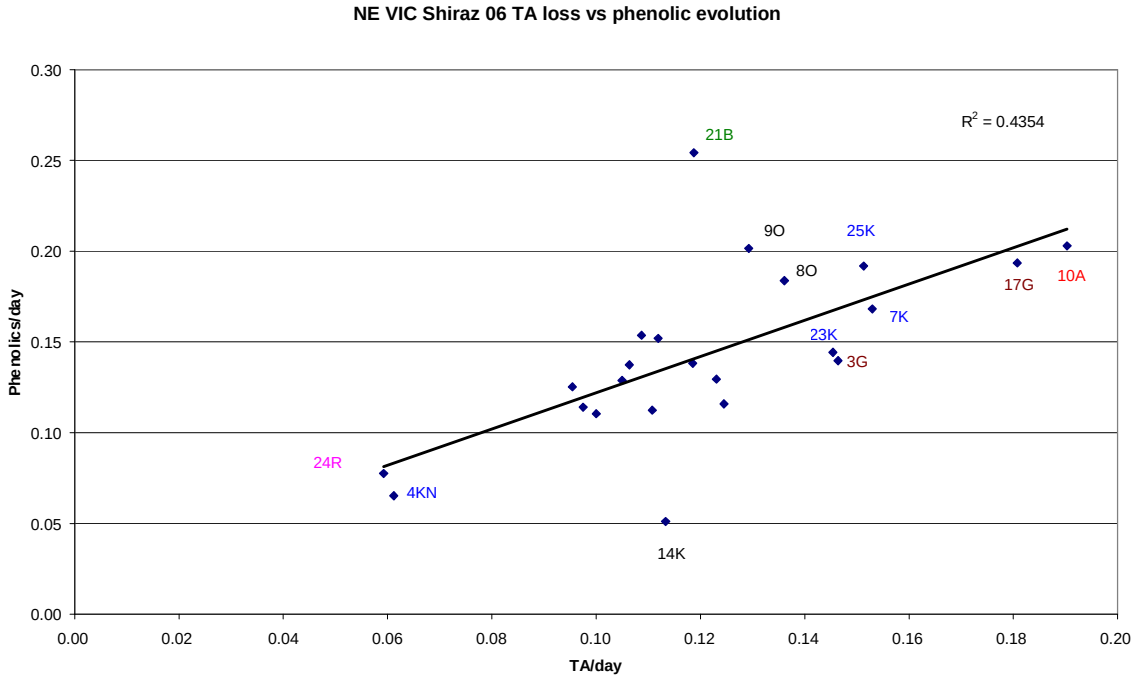


Fig. 178: A wide range of phenolic concentrations per g berry fresh weight were achieved in the bracket of 20,000 – 30,000 degree h. Berries with more than 10% shrivel have very high phenolics and are excluded from the statistics.

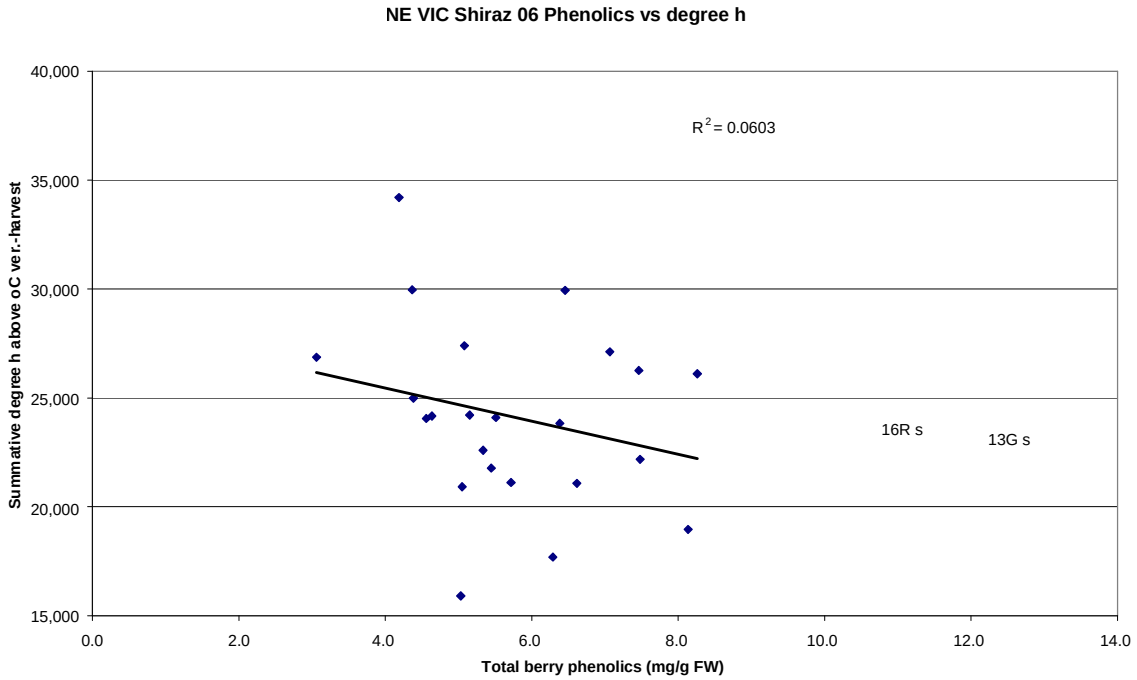


Fig. 179: Flavonols as an indicator of UV radiation intensity were highly correlated with total phenolics. This means that low radiation intensity in canopies did not favour phenolic formation and/or maturation, and even if the shrivelled samples 13 and 16 are disregarded there is a linear benefit of higher flavonols.

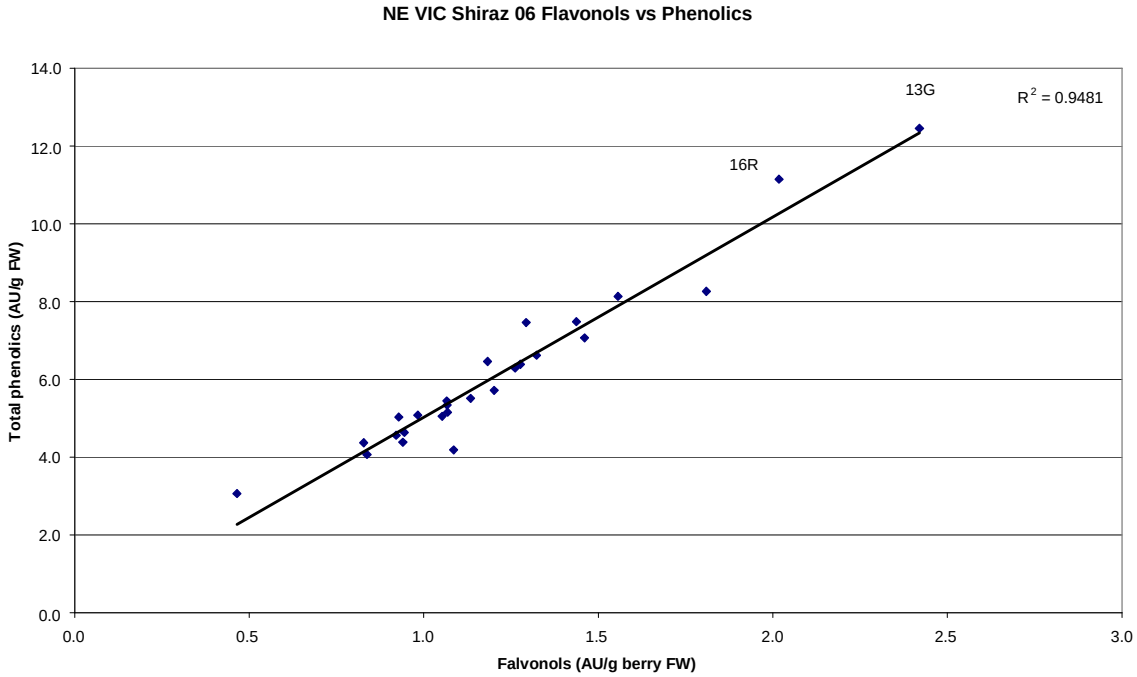


Fig.180: Anthocyanins seem to be much less influenced by UV radiation levels.

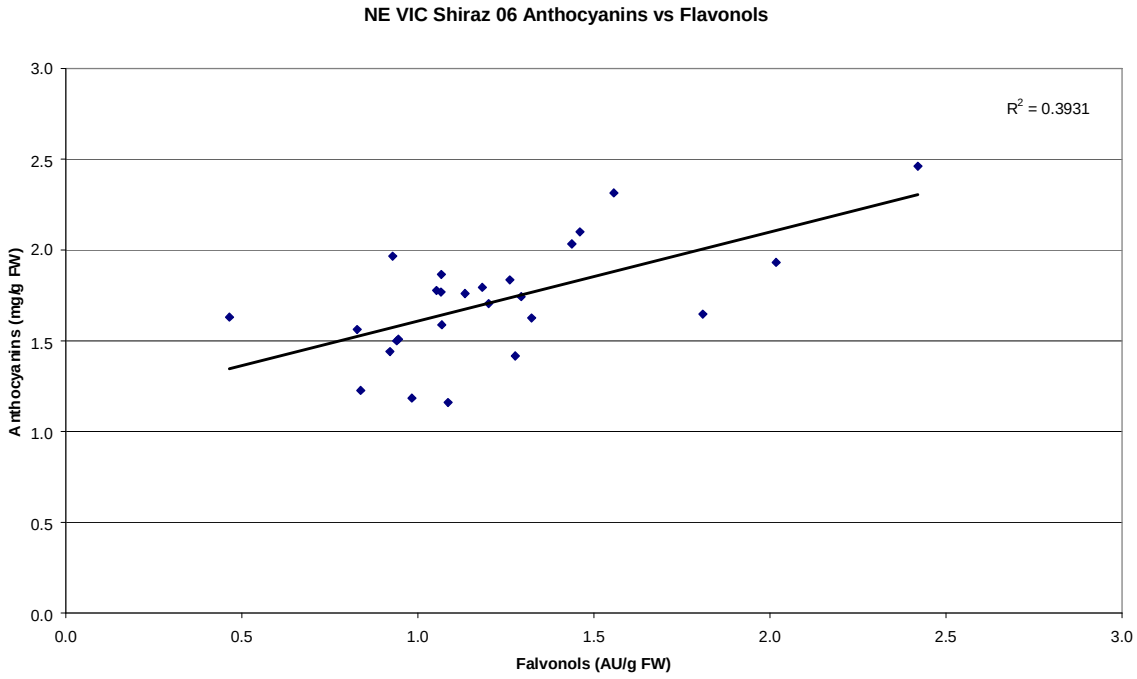
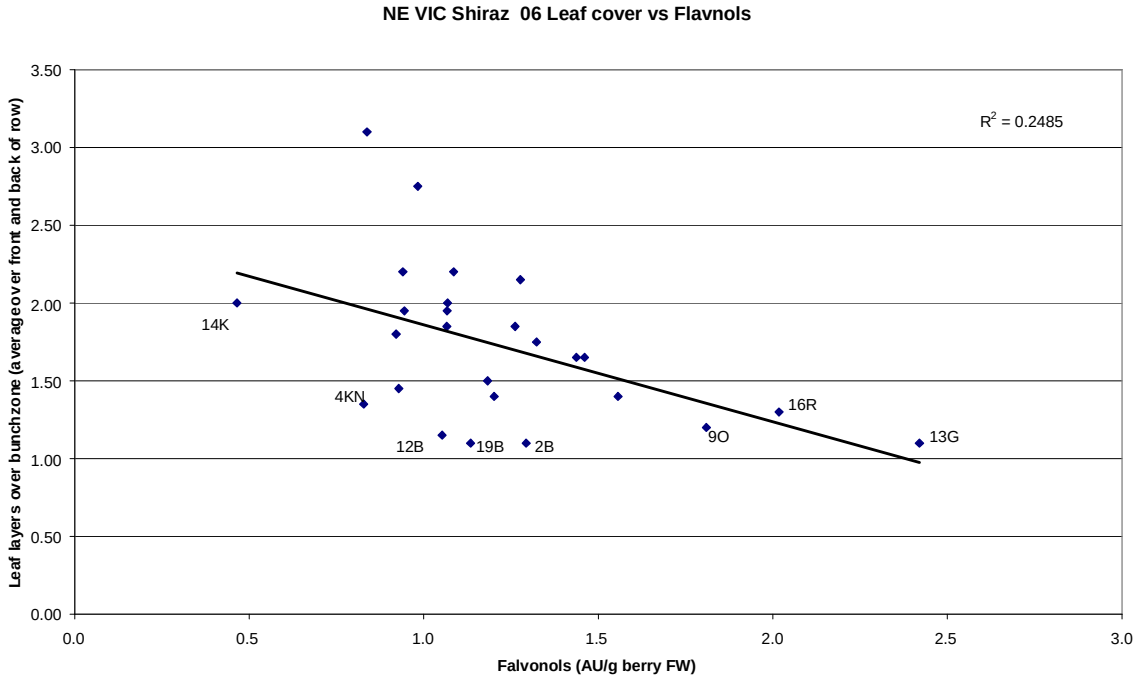
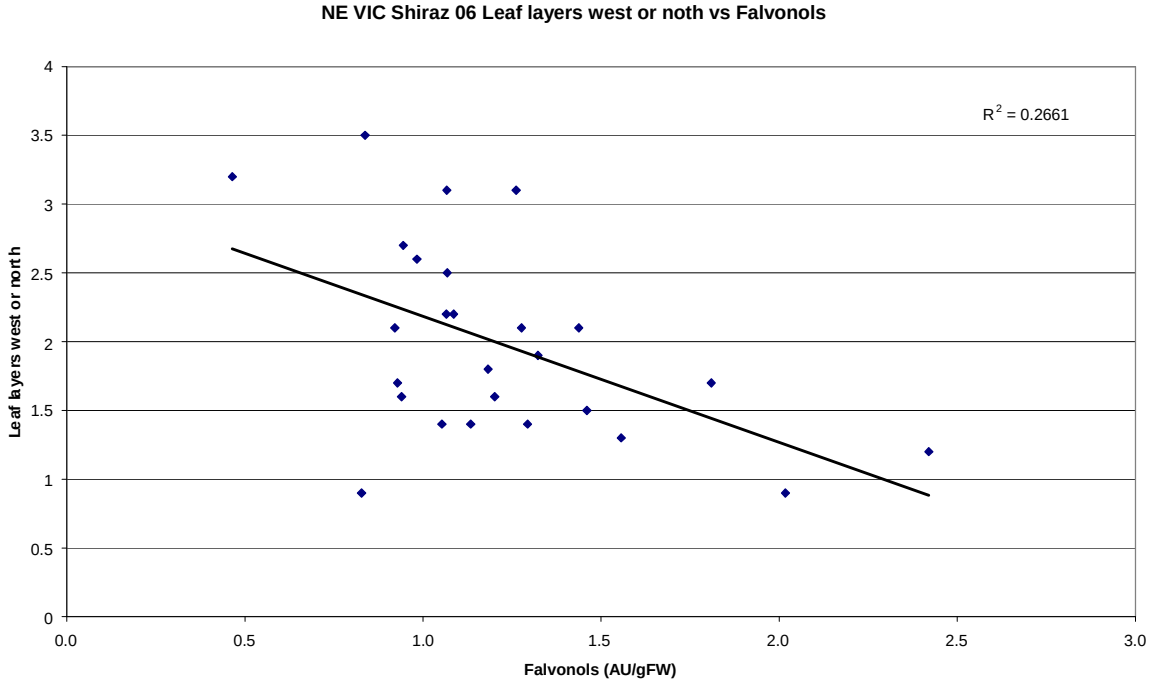


Fig. 181: Flavonols were highest in highly exposed bunches and very shrivelled berries but medium flavonol levels occurred at a variety of leaf cover.



Flavonols were not influenced by hangtime or heatloads.

Fig. 182/ 183: Leaf cover to the hotter side was more influential than to the morning sun or south facing side.



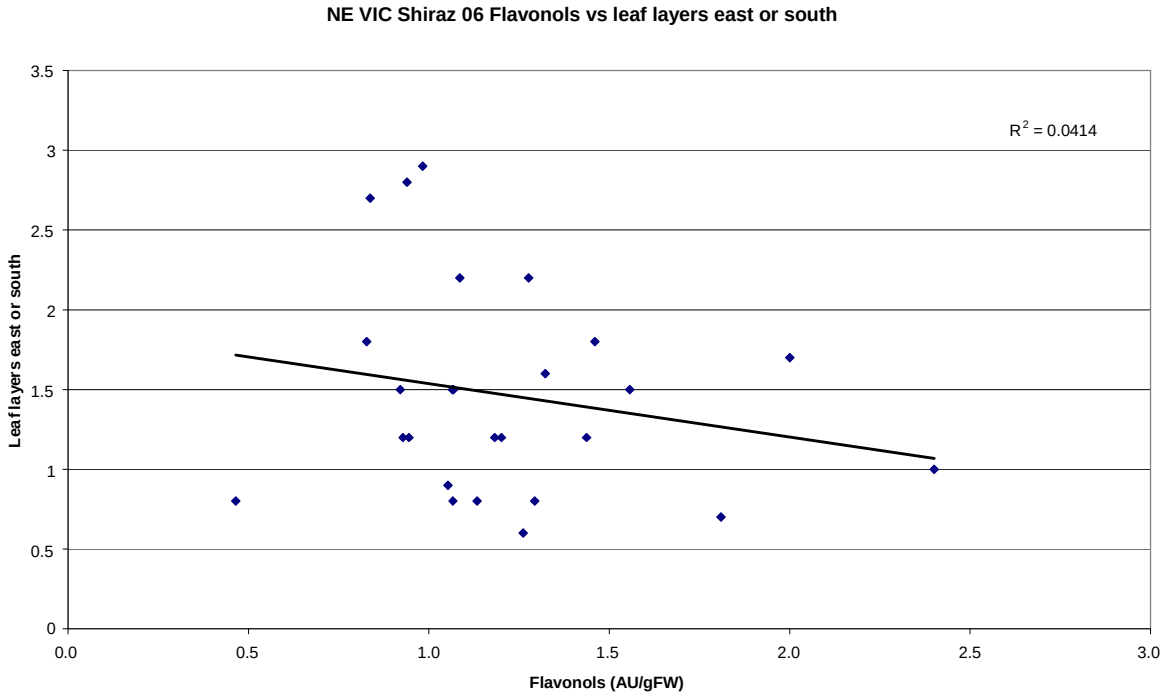


Fig. 184: Average degree hours in the bunchzone were in 2006 much warmer than in 05 and seemed to have led to phenolics between 4 and 8 AU/g FW.

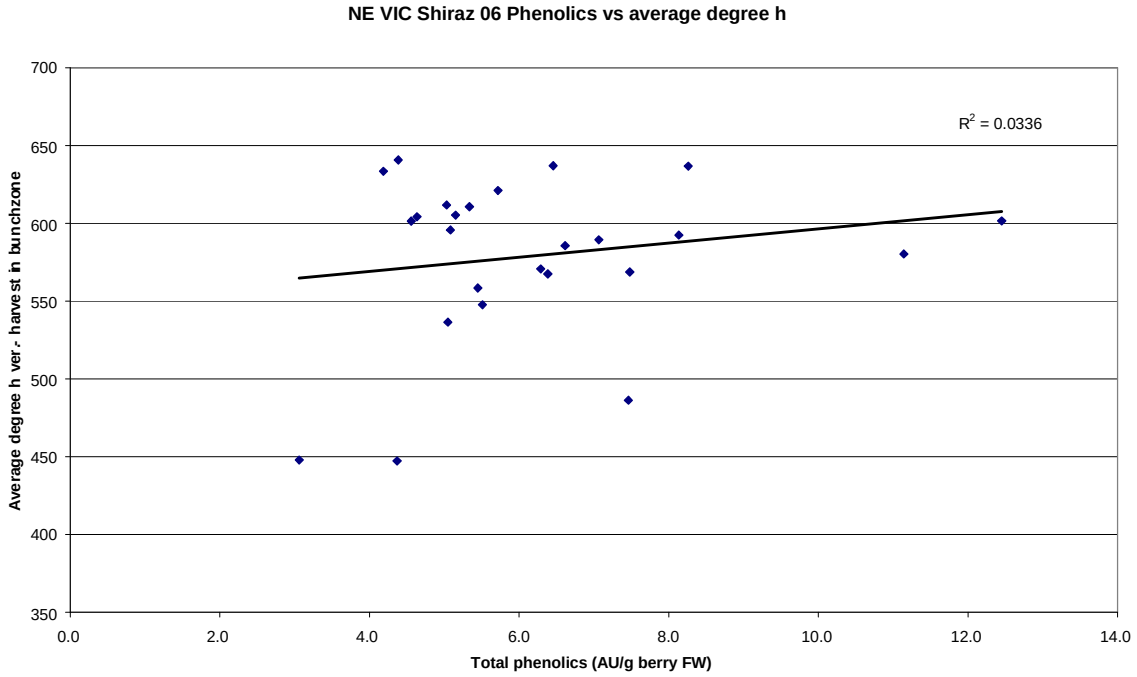


Fig. 185: Last year there was a slight benefit in having higher average bunch zone temperatures.

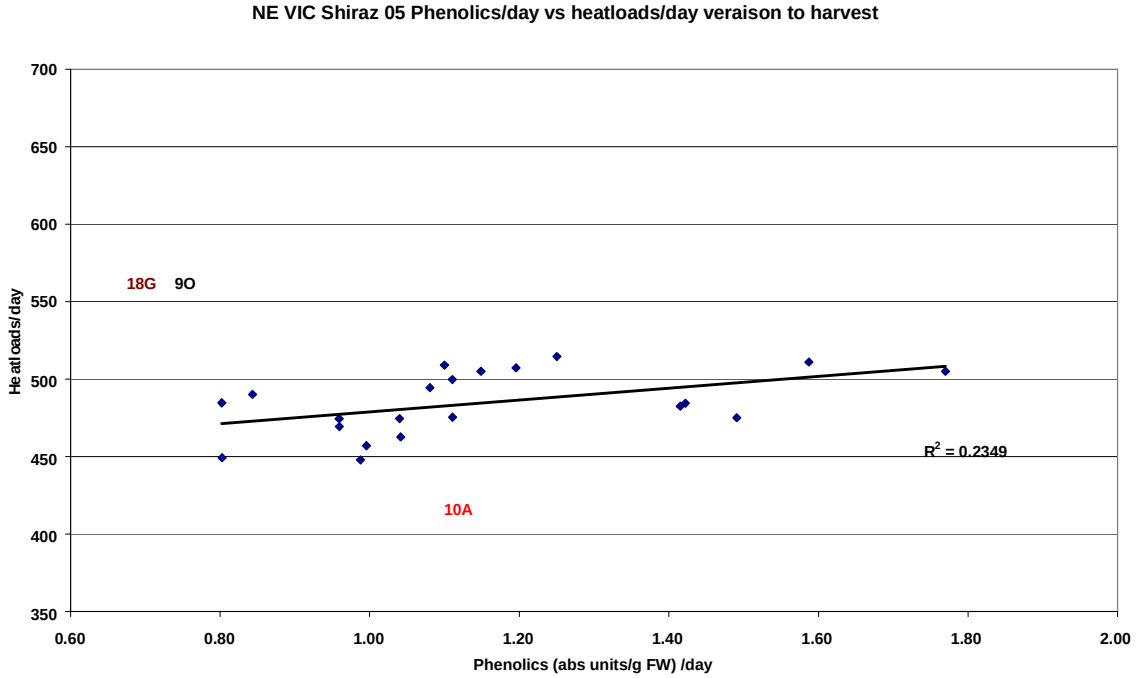


***Fig. 186*: Small and / or shrivelled berries had more phenolics/g FW.**

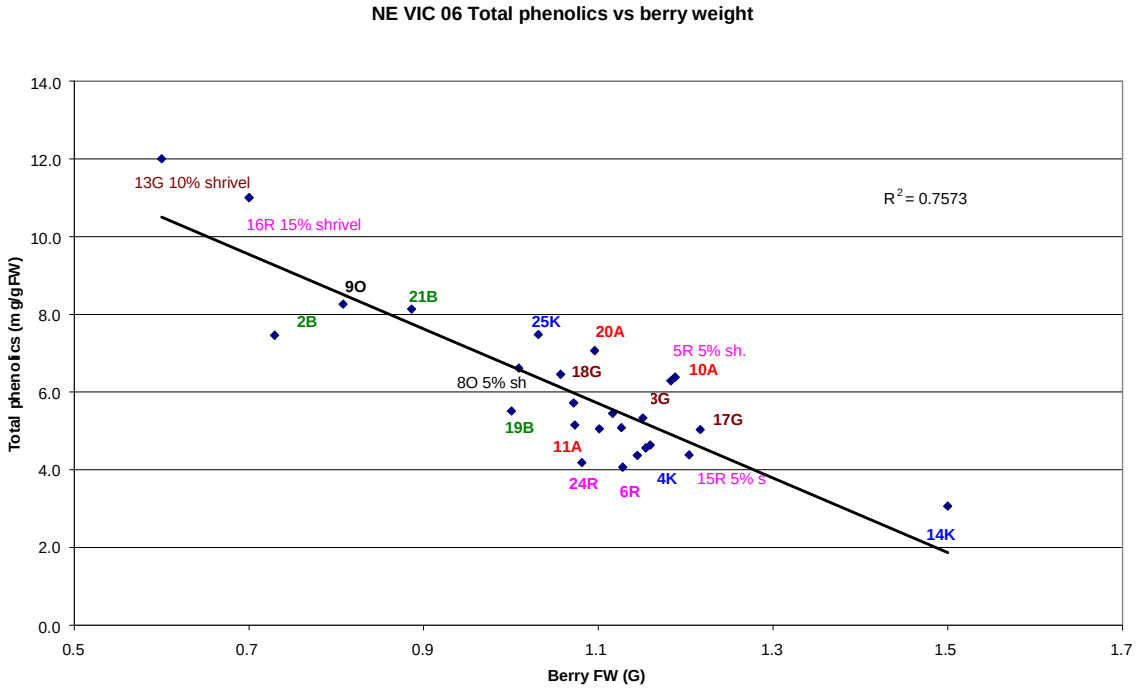


Fig. 187: This was less expressed when there was rain before harvest and when the skins were peeled off so no seed phenolics were measured.

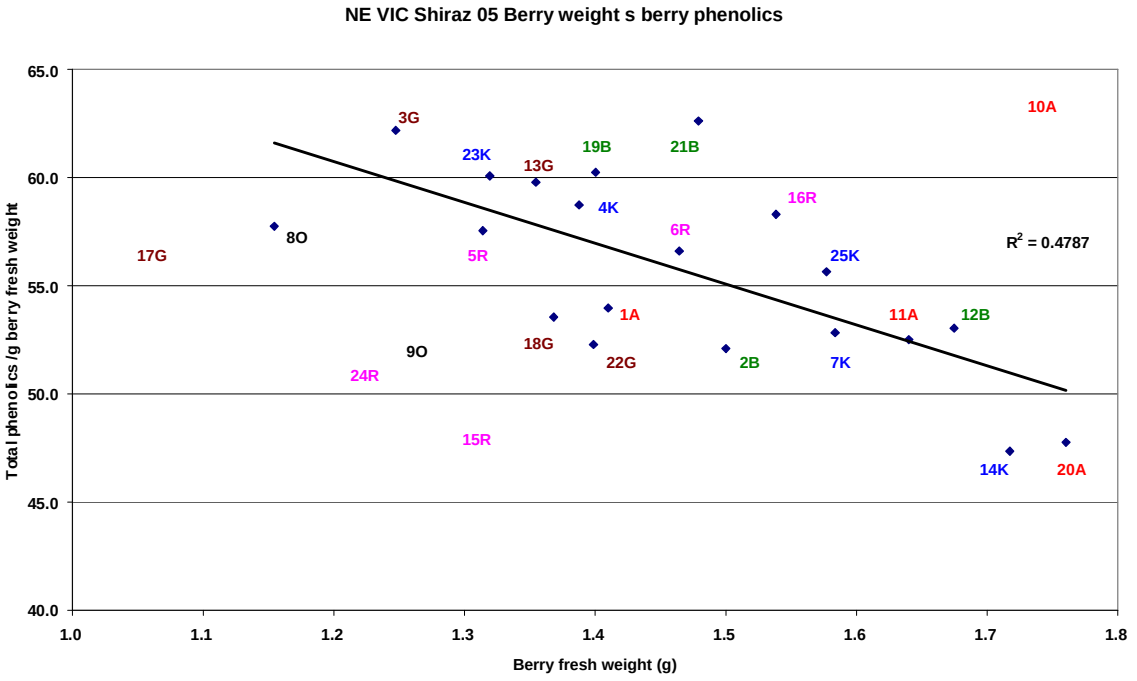


Fig. 188: As this year's berry analysis grinds up the seeds as well, phenolics are unreasonably high in berry extracts and may not in the same manner transfer into wine. But their speed of formation is similar.

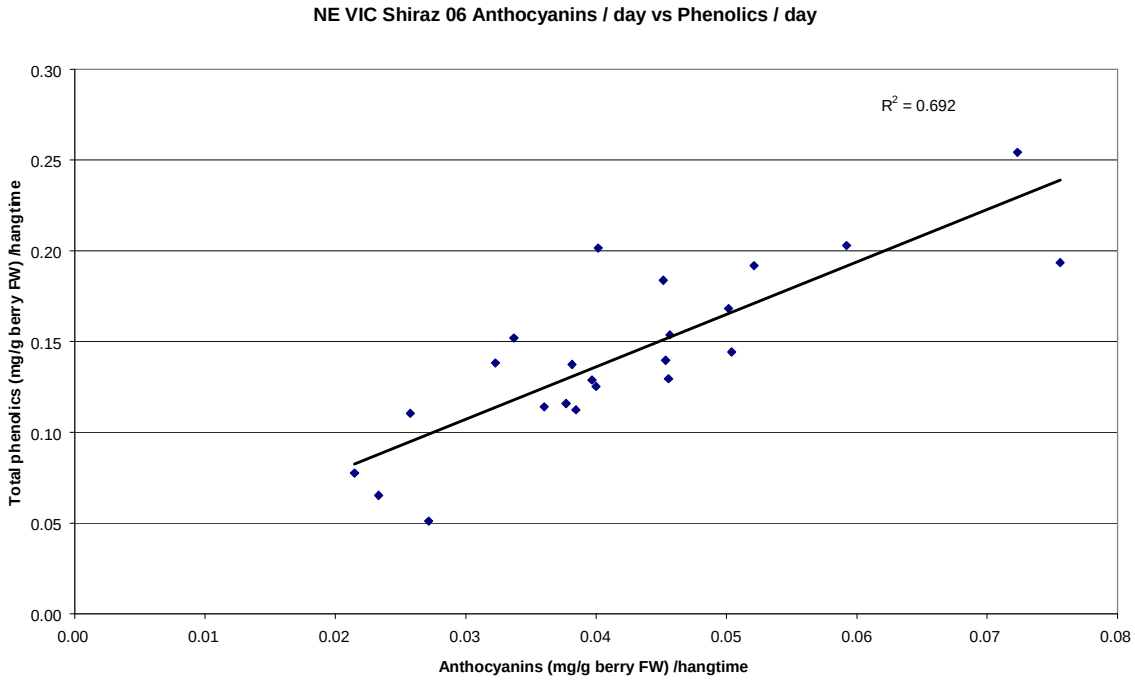


Fig. 189: In 05 there was a good correlation between berry weight and seed weight (with rain in February and most vines not dry).

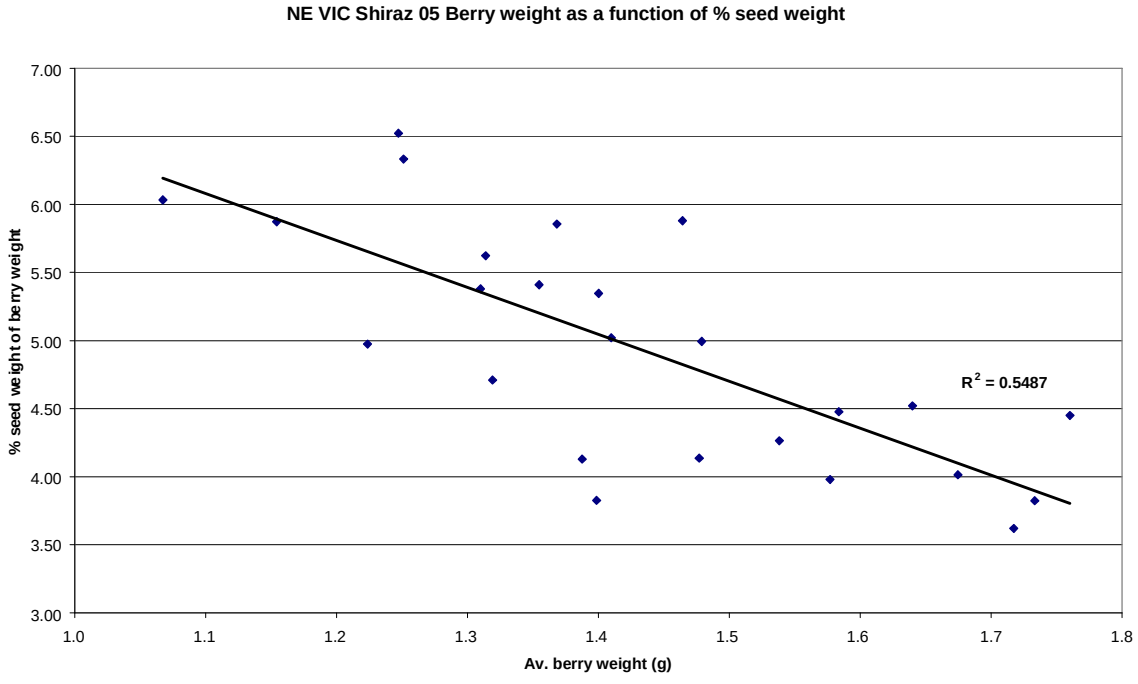


Fig. 190: In 2006, when harvest ratios of phenolics to anthocyanins are compared, the curve is not linear like in 04 but shows the hotter vineyards in the lower corner like in 05 and cooler vineyards in the upper right corner. The relationship is of course influenced by berry size in particular in the rainless hotter year 06.

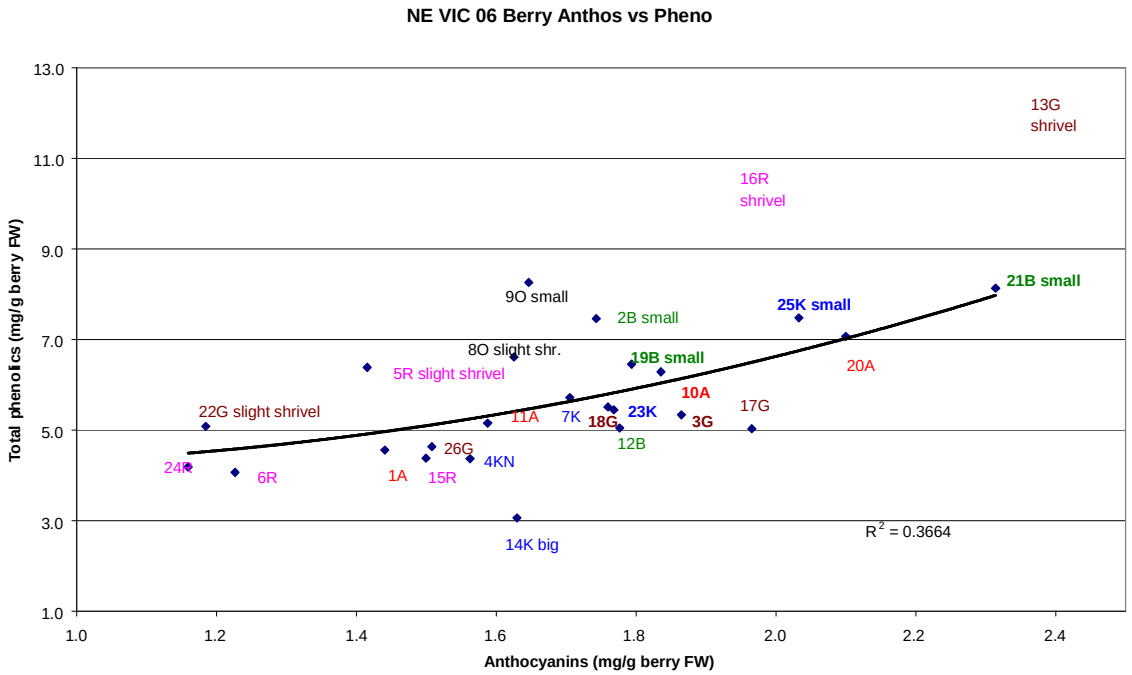


Fig. 191: Hotter vineyards have more skin phenolics and less anthocyanins and cooler vineyards less skin phenolics than possible but good anthocyanins. Vineyard 4 cannot be compared.

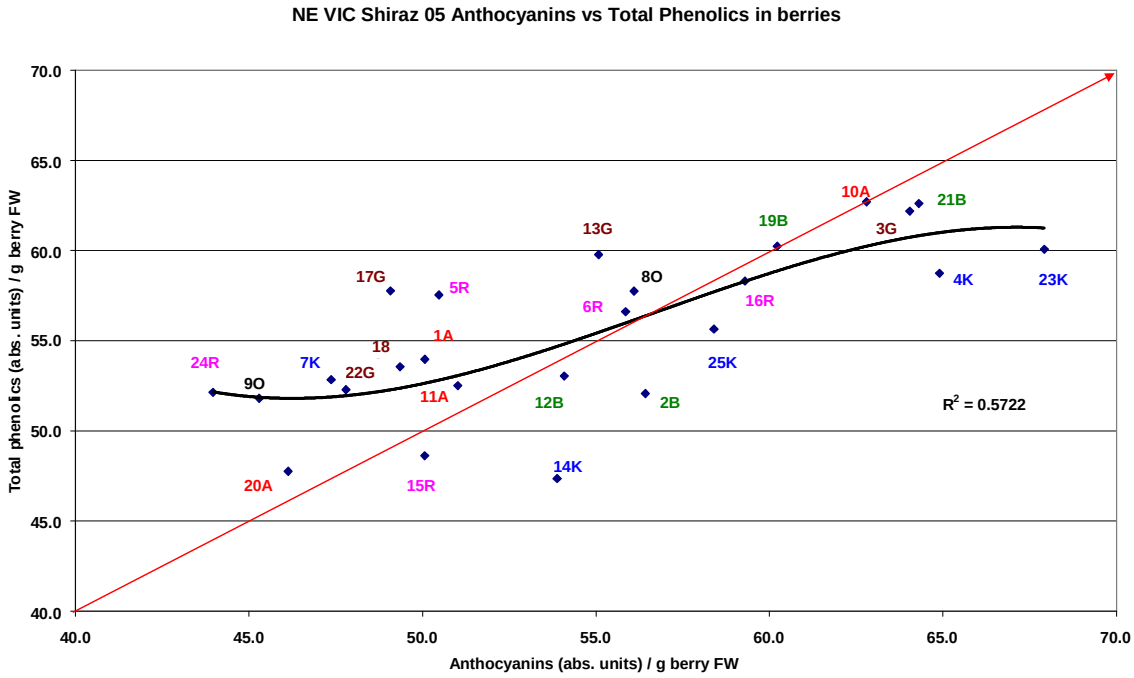
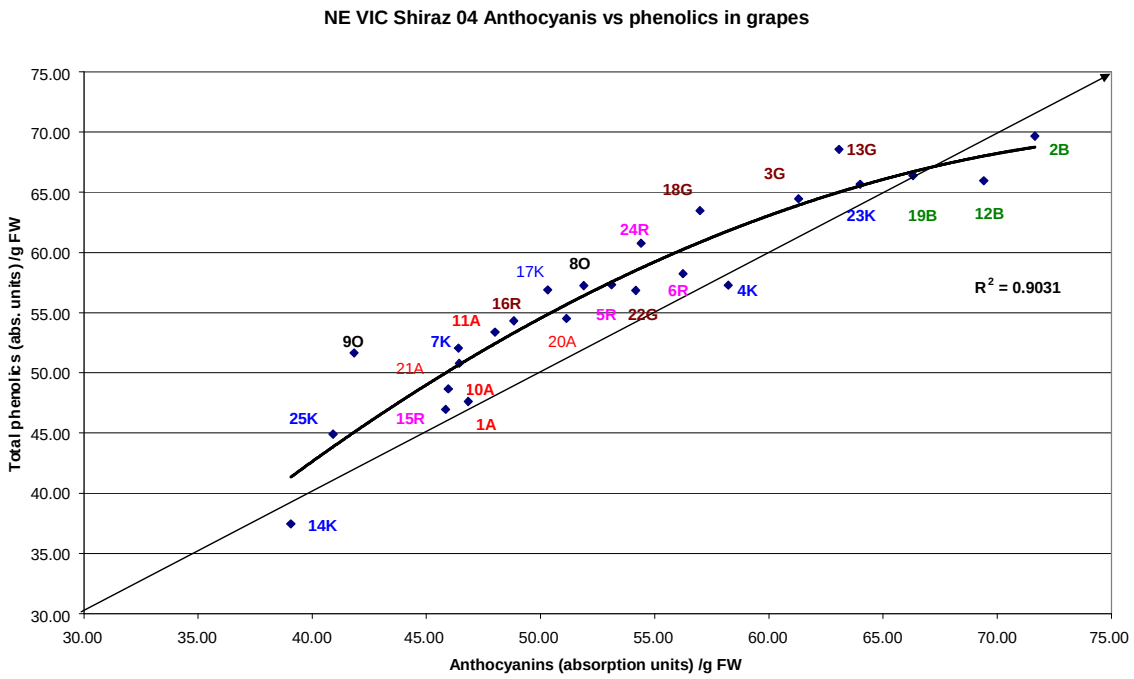


Fig. 192: Anthocyanins vs. phenolics at harvest from the 03/04 season.



Berry Sensory Assessment

Berry Sensory Assessment (BSA) was performed pre harvest in the field according to *Winter, Whiting and Rousseau (2004).* A field assessment sheet was filled in by the same assessor (S.L.) for each vineyard using 6 randomly chosen bunches to represent all parts of the vineyard. Results were transferred to a table **(Tab. 5)** and presented with the pre harvest berry characteristics of interest to the winemaker together with the duration of ripening and the summative degree hours (base 0) (**Tab. 4)** At a first glance it is obvious that the pulp maturity (sugar/acid balance) is generally good, the skin maturity often sufficient, but pulp aroma and seed maturity are lagging behind. In comparison to the 05 harvest the BSA traits are physiologically more advanced, ripening was faster, although on average bunch zone temperatures are not much higher (due to 2 very cool bunch zones).
The berry traits are more similar in this year compared to the last as can be seen in Fig. 166 and 167. Vineyard 4 is not comparable as it is a different one in 06 and vineyard 26 is new.

Fig. 193: Berry BSA results for 26 vineyards pre harvest 06

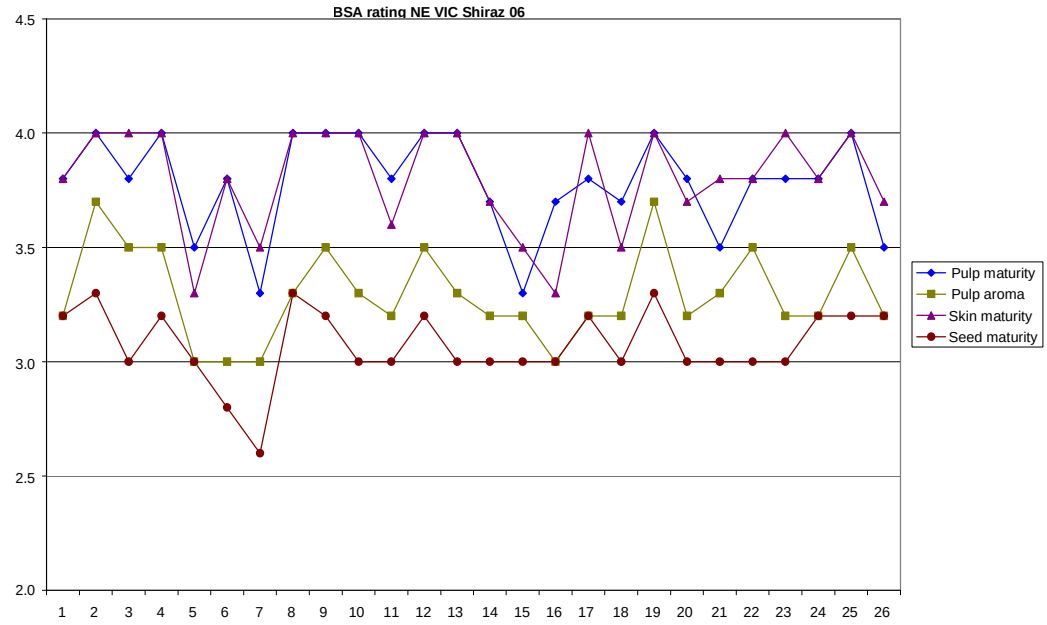
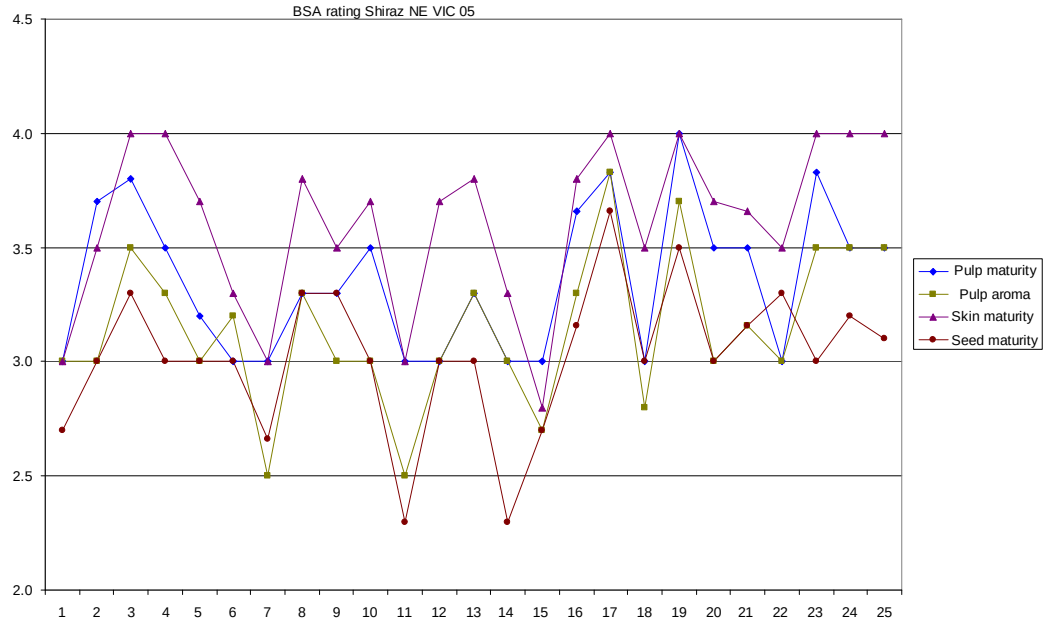


Fig. 194: Berry BSA results for 26 vineyards pre harvest 05



Acid /sugar balance is expressed in pulp maturity. This year many vineyards were riper.

Fig. 195: Many vineyards achieved better pulp maturity in 06 compared to 05

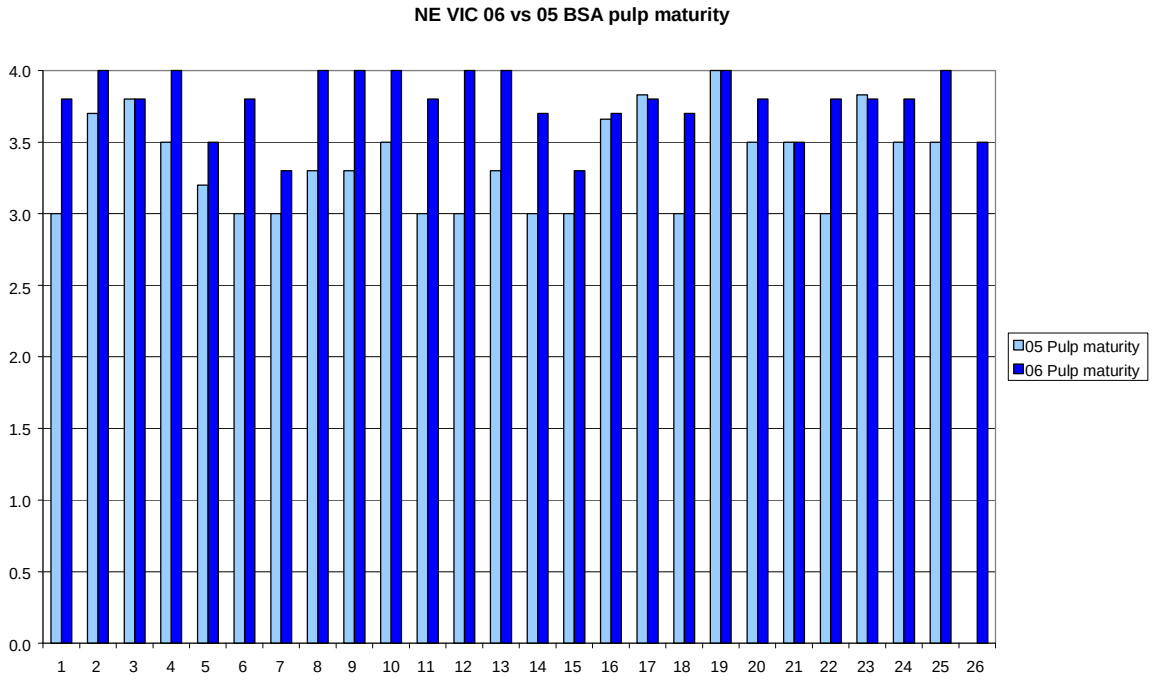


Fig. 196: Many vineyards achieved fruitier pulp aromas in 06 compared to 05 but some also had less fruitiness.

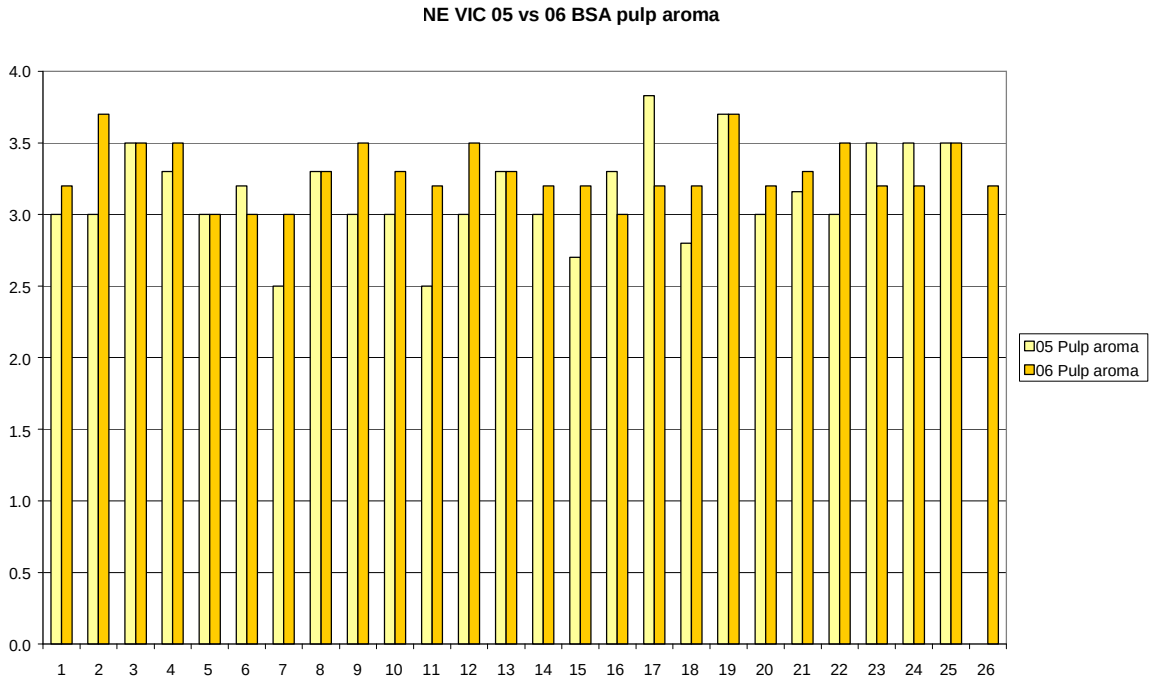


Fig. 197: Many vineyards achieved riper skins in 06 compared to 05

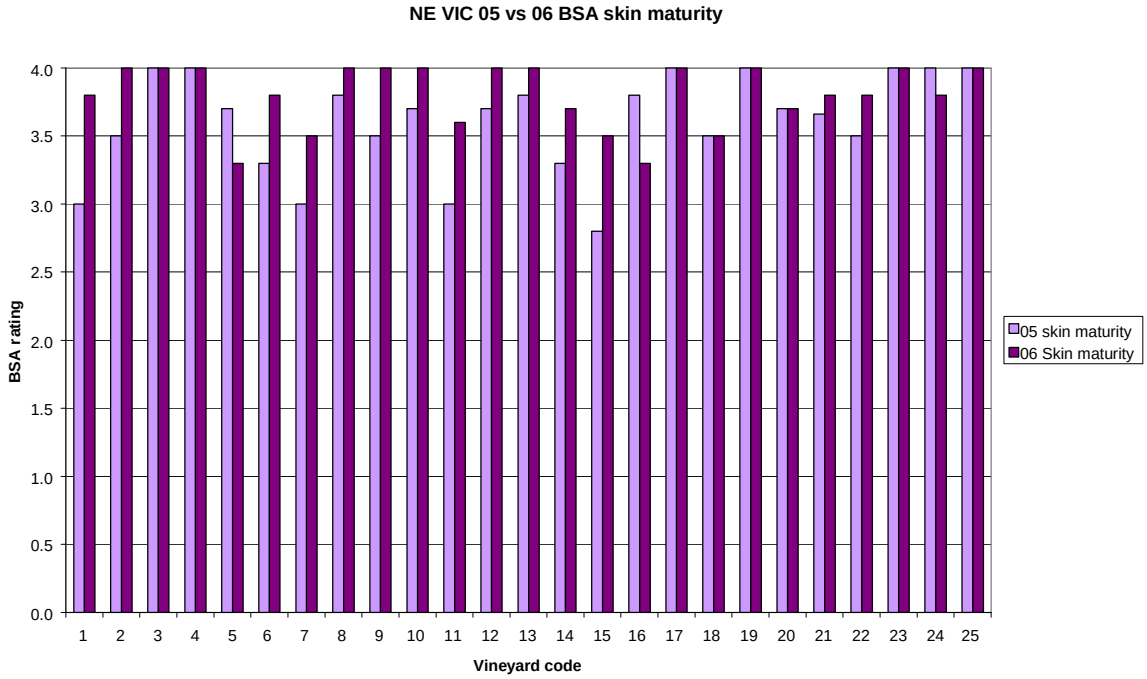
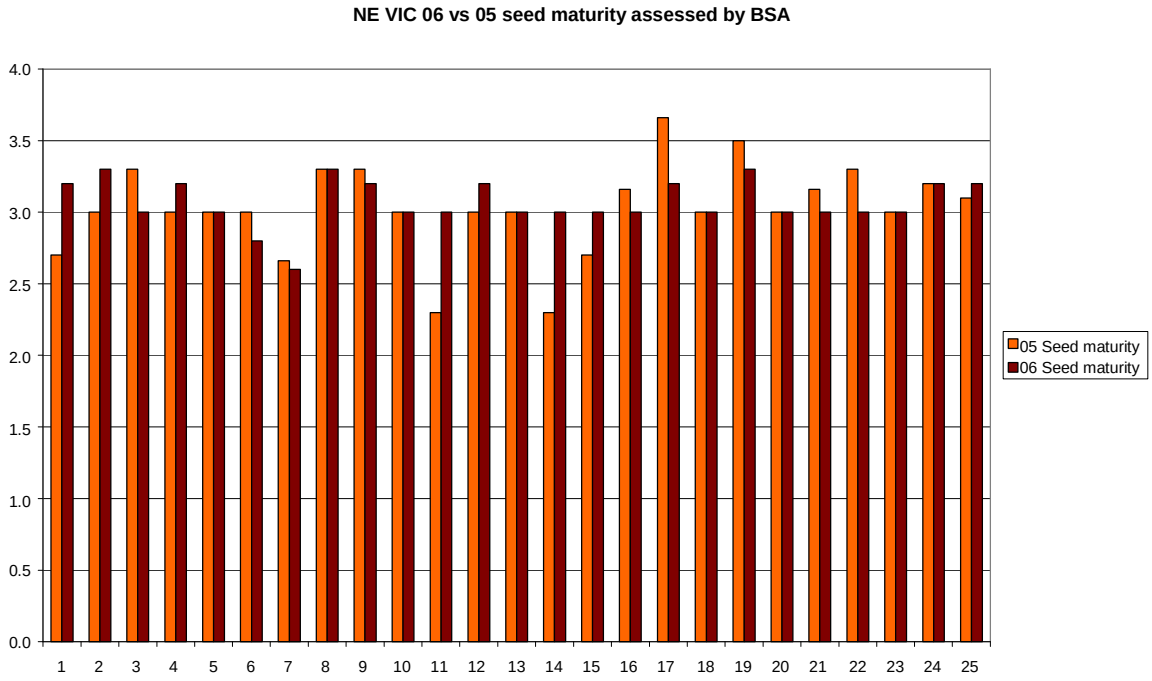
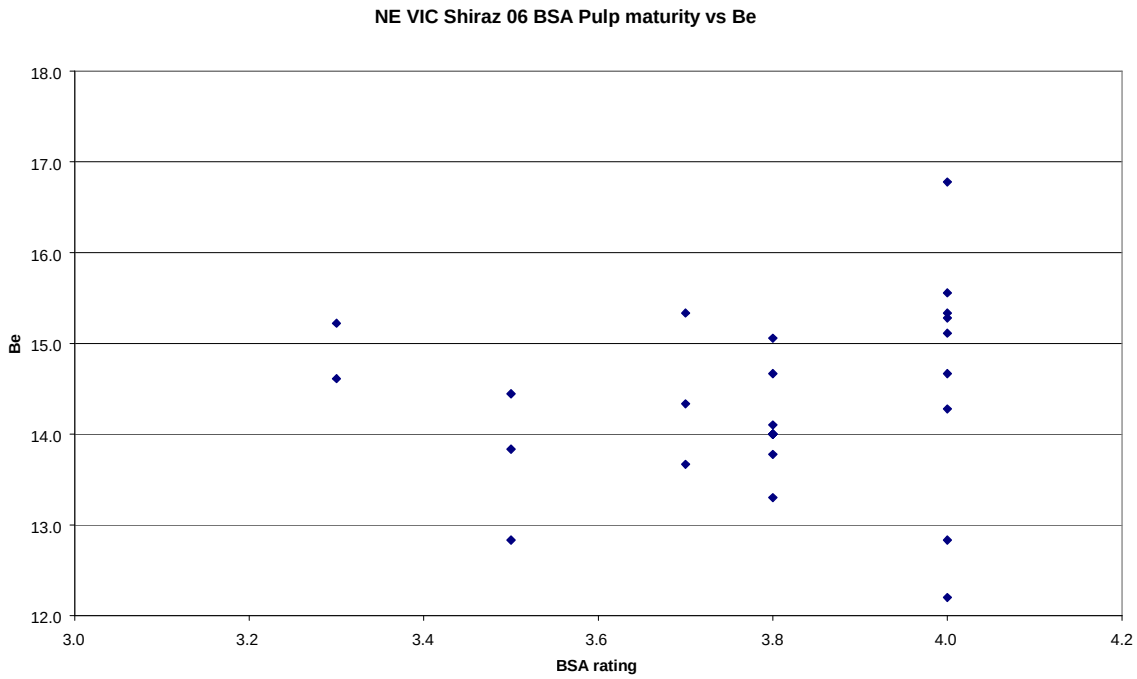


Fig. 198: Seed ripening was difficult in both years.



Pulp maturity (good sugar to acid balance) did not depend on a high Baumé. In fact good rates were achieved at a large spectrum of Baumé.

Fig. 199: Pulp maturity was not related to Baumé.



In this warmer year it was crucial that the fruit did not lose its acid too fast. TA at harvest of course is brought about by several factors, including bunch warmth and hangtime.

***Fig. 200:* Pulp maturity was slightly better when acidity was retained a little better.**

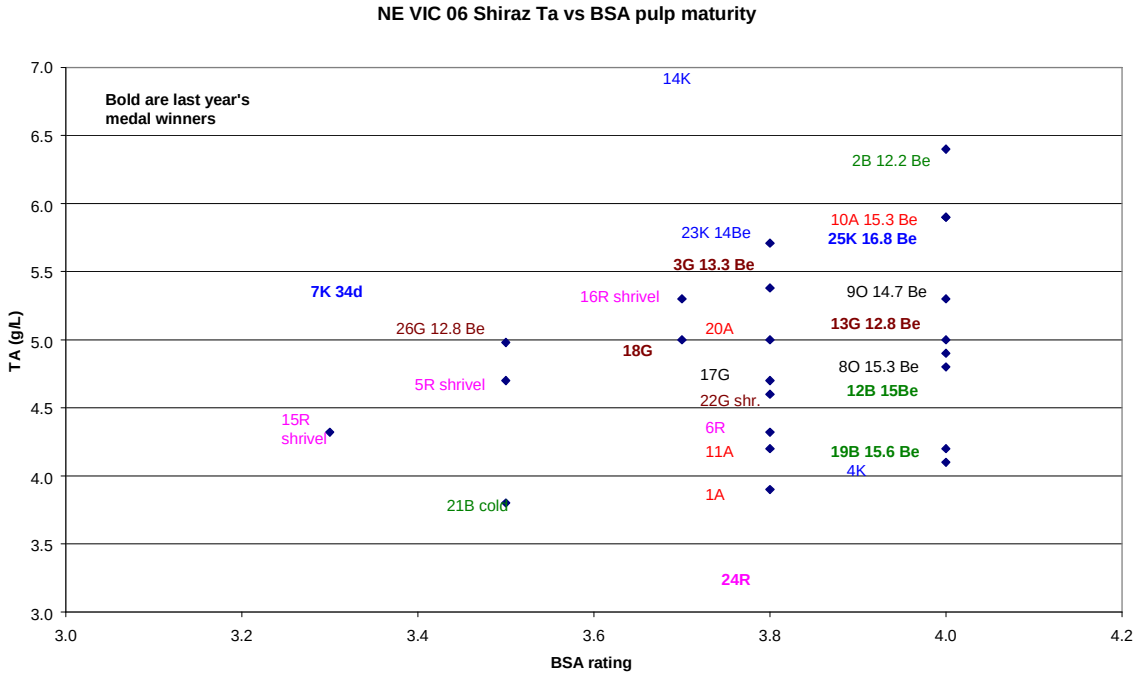


***Fig. 201*: When shrivelled and shaded berries were excluded, there was a trend that hotter berries had a lower pulp maturity rating (most likely to slower sugar load)**

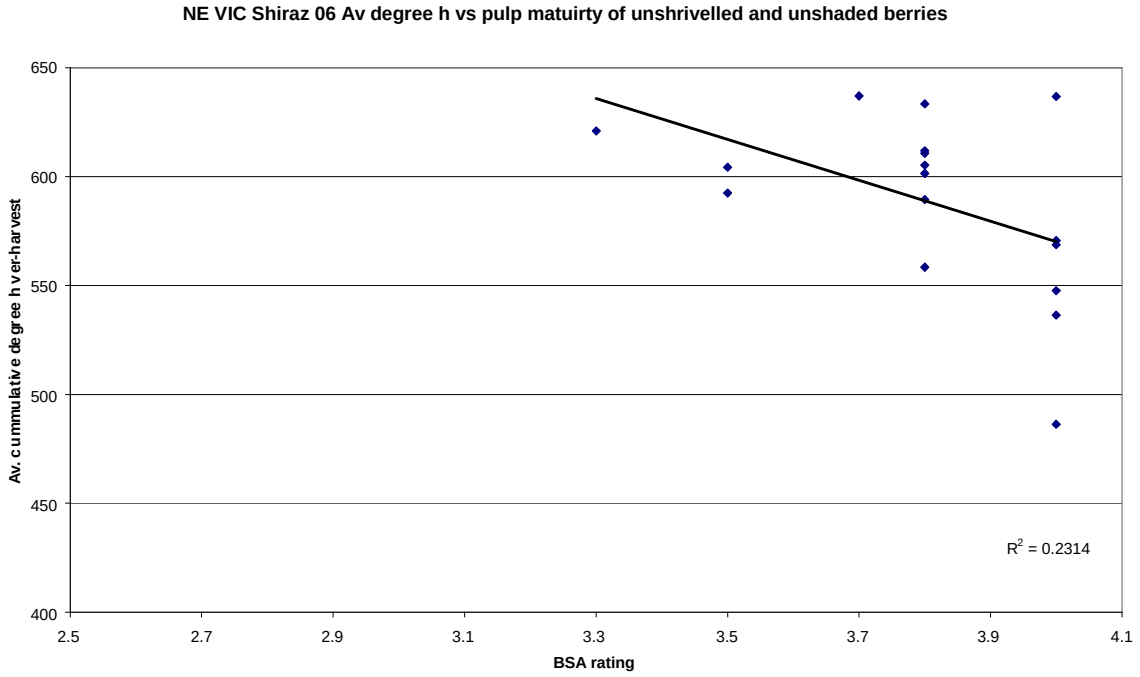
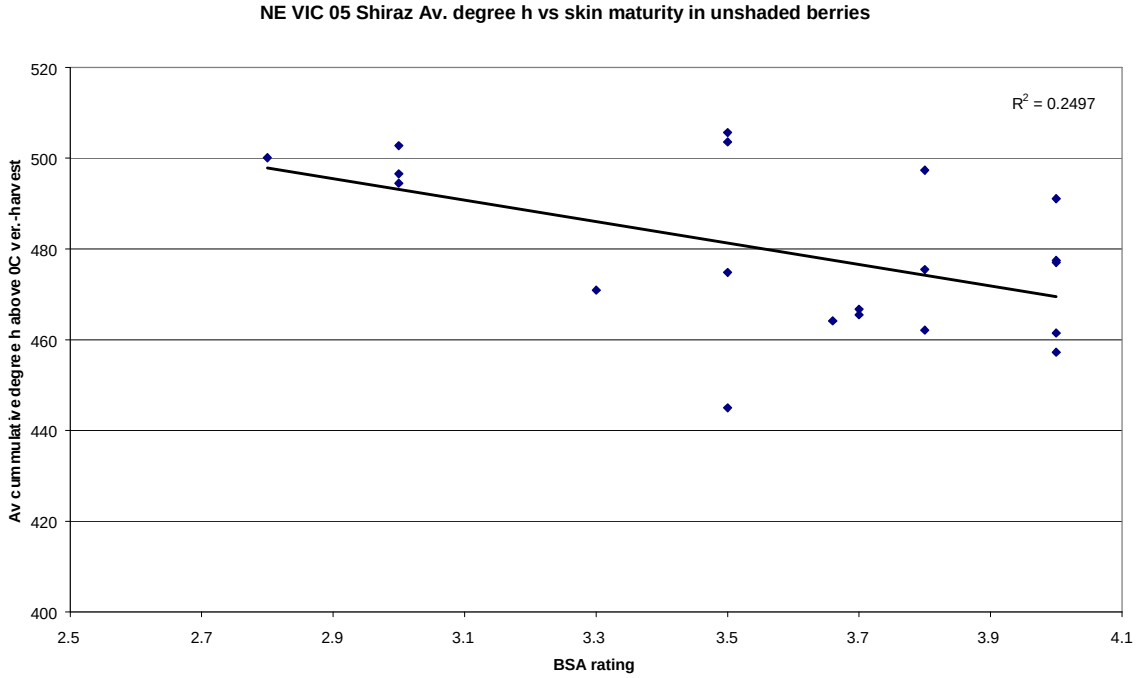
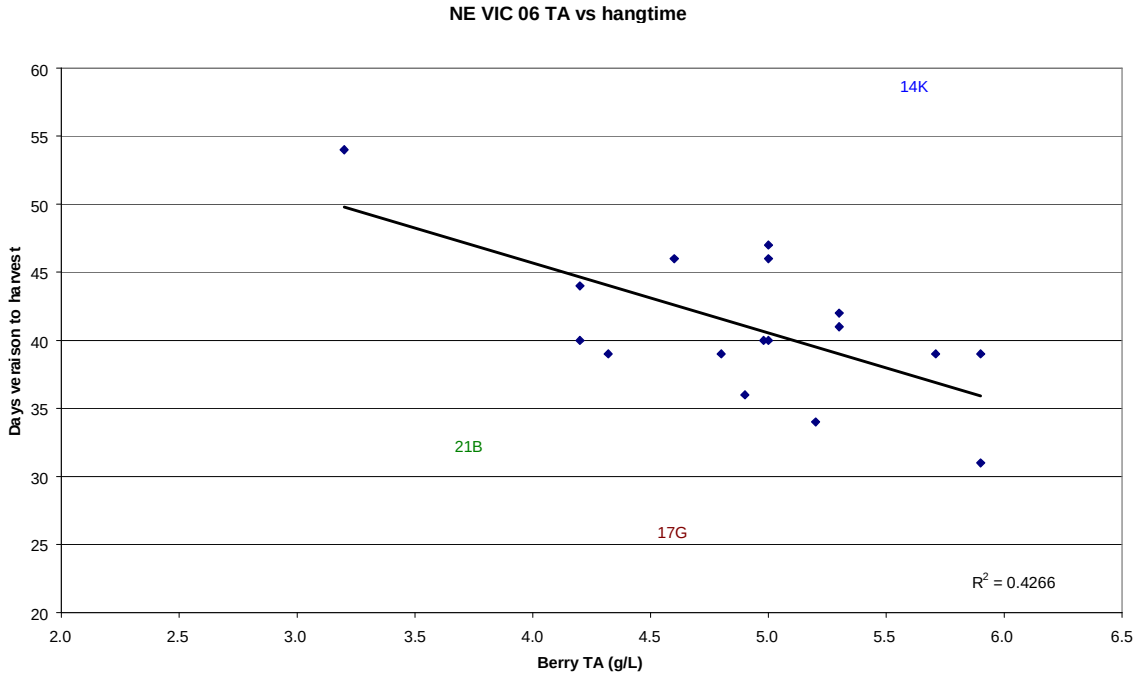


Fig. 202: There was much more herbaceousness in the cooler year 05



Shorter hang times may help with acid retention but may negatively influence aromas and skin and seed maturity.

Fig. 203: Shorter hang times can result in higher TA and thus better pulp maturity balance.



It was found that there is no correlation between hangtime and aroma development in particular when bunches which had developed shrivel or water stress are not included (sh after the code). Long hangtime under wrong conditions also does not increase aromas (too cold, too hot etc).

Fig. 204: However shorter hang times may mean lower pulp aromas?

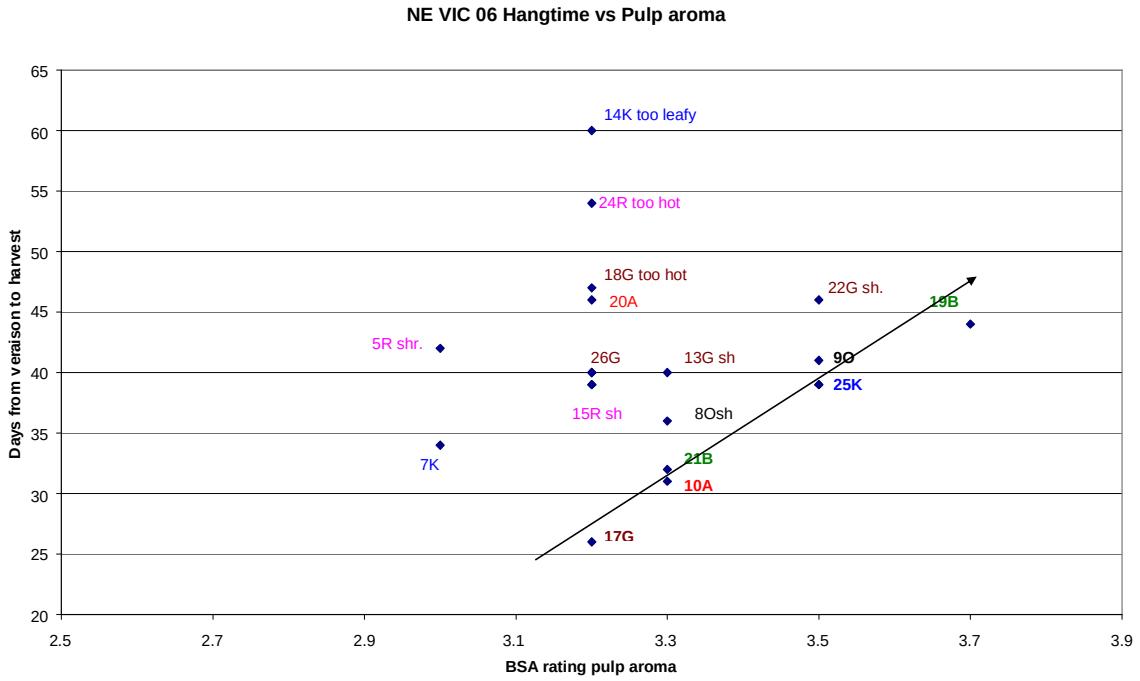
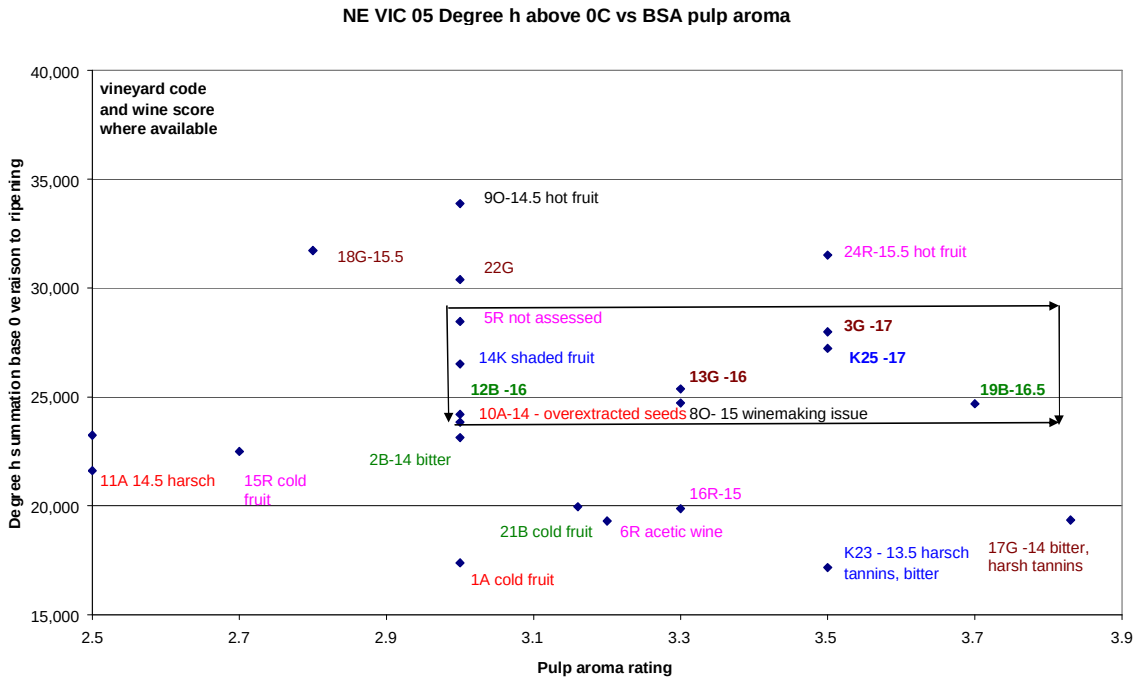
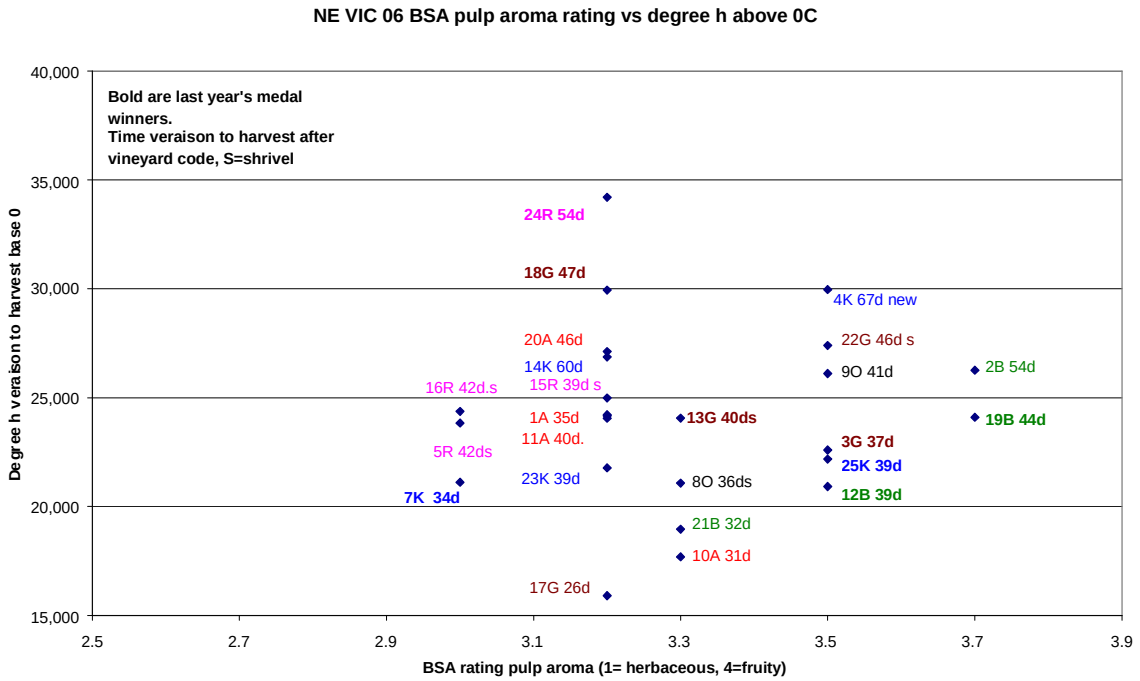


Fig. 205: Hang times in the right temperature summation bracket (23,000 – 30,000 degree h) were in 05 a good predictor for pulp aroma outcomes and wine scores and wine descriptors (some adverse ones next to wine score)



In 06 some of the vineyards had lower summations due to shorter hangtimes due to faster sugar loading and acid loss.

Fig. 206: **BSA Pulp aroma scores vs. bunch zone temperatures base 0°C veraison to harvest. This year vineyards had lower heat summations due to shorter hangtimes (17G hung a week longer than degree hours would suggest).**



When shrivelled and shaded berries were excluded there was a relationship between pulp aroma and average degree hours veraison to harvest:

Fig. 207: Higher average temperatures led to lower pulp aroma scores in this hotter year.

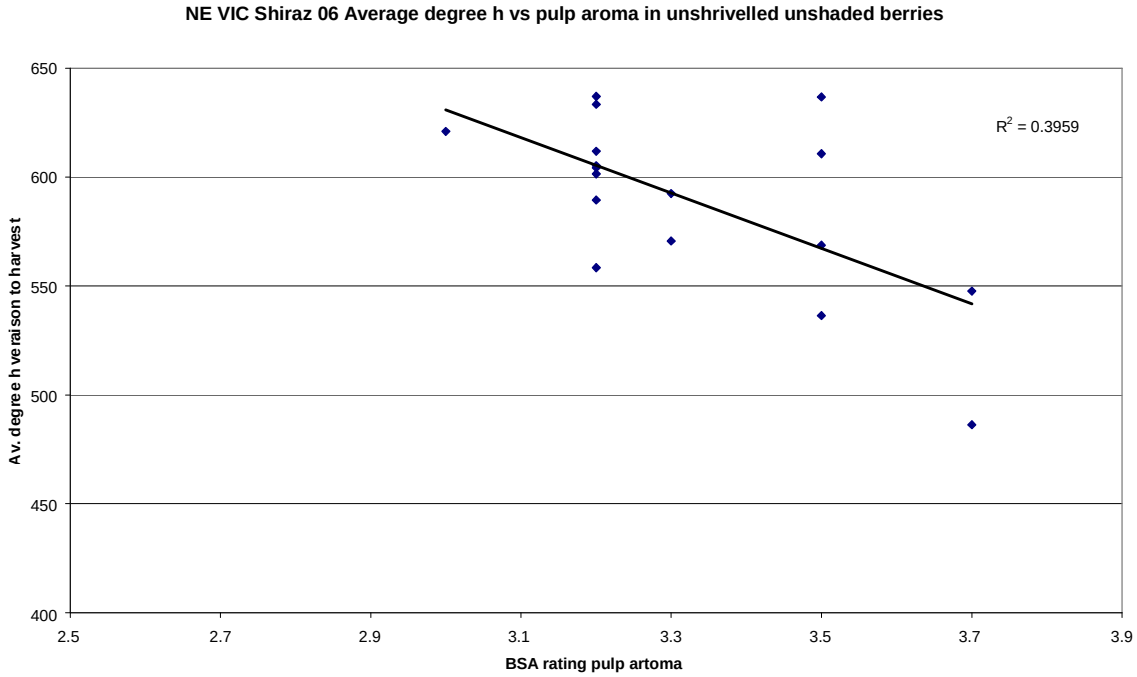


Fig. 208: Pulps were far less ripe in 05 but showed the same trend

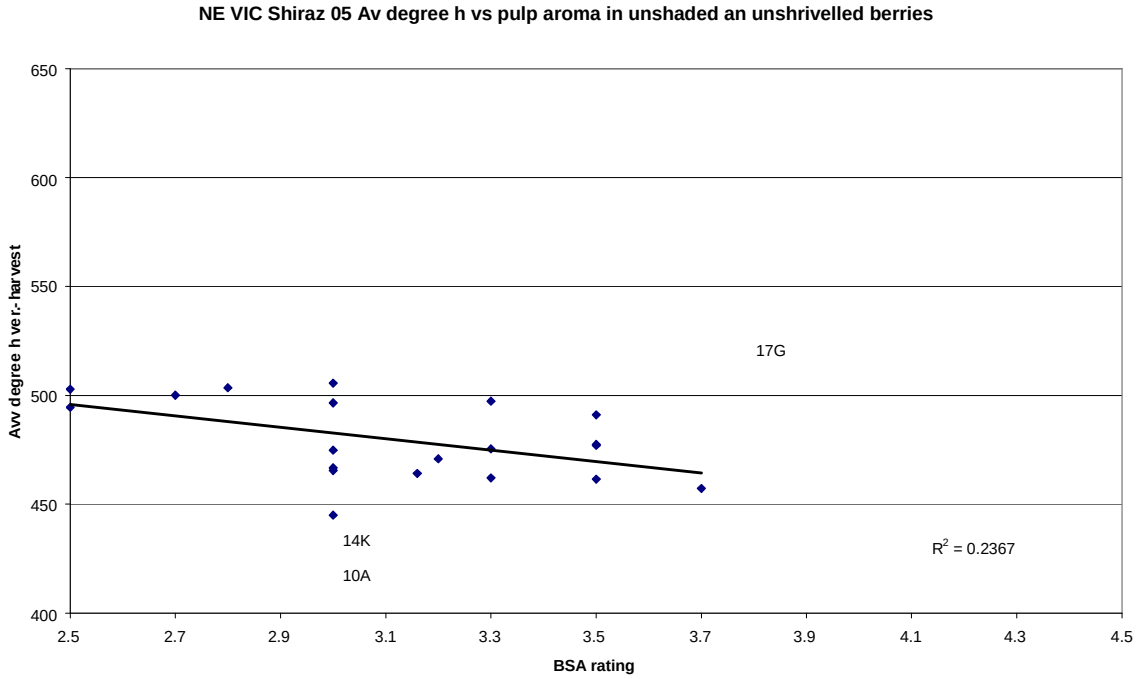
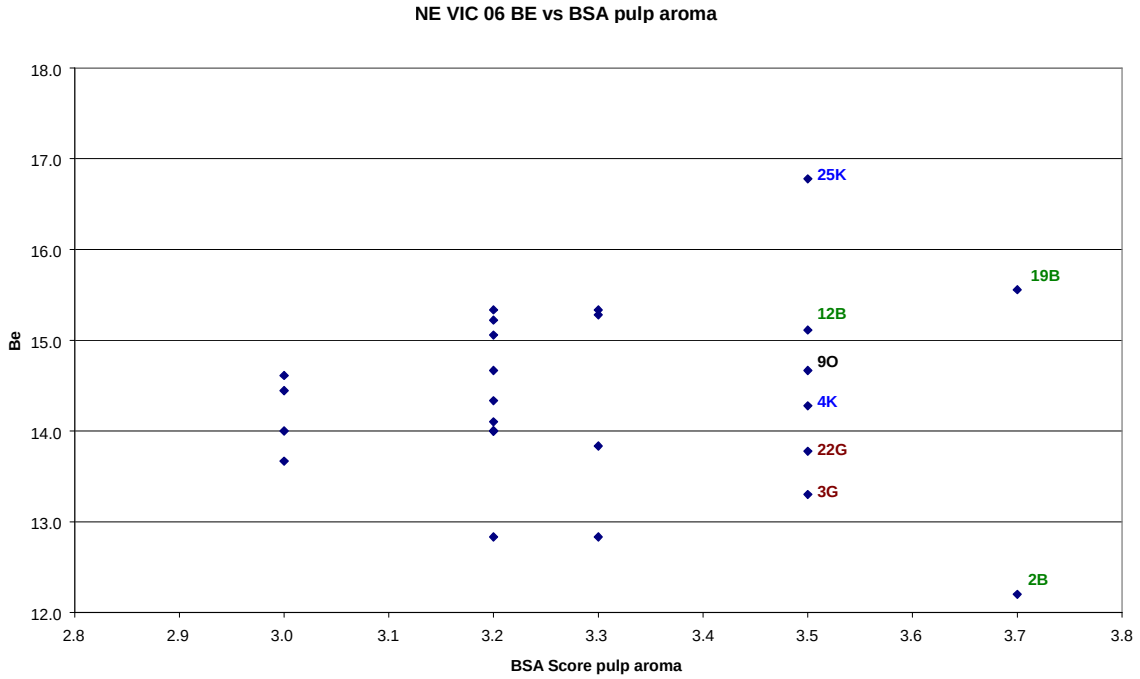


Fig. 209: Acceptable pulp aromas were achieved at a large spread of Baumé values.



There was no correlation between berry TA and pulp aromas.

Fig. 210: Good skin maturity also did not depend on Baumé.

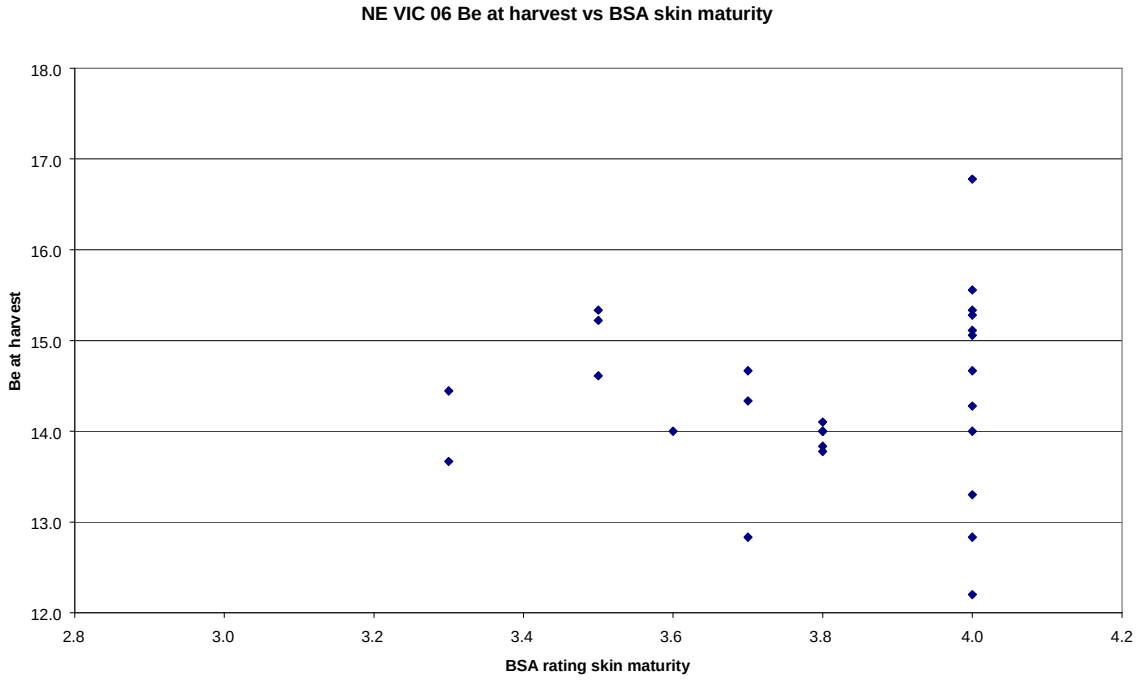
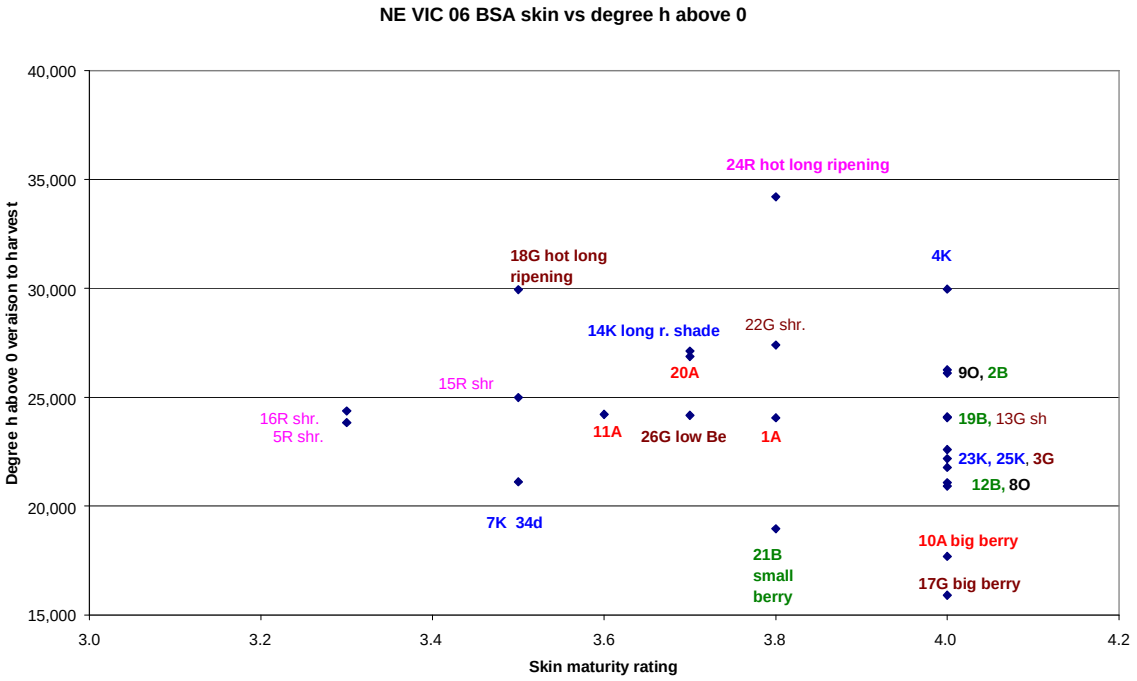


***Fig. 211*: In the season 05/06, good skin maturity is reached at various degree hour summations above 0C.**



It is of interest to note that the year 06 was hot and dry thus a testing time for grape ripening. Under those conditions crop size may play a role in particular in conjunction with high evaporative demand and various irrigation volumes (which have not been monitored in this study). Smaller crops may have a better water situation and thus ripen better under heat loads. If a larger crop is to be ripened it needs to be under lower heat loads as in 4K. This relationship of water, heat and skin maturity deserves further attention in warm years under controlled irrigation.

Fig. 212: Heat loads in conjunction with water shortage or larger crops may inhibit skin maturity.

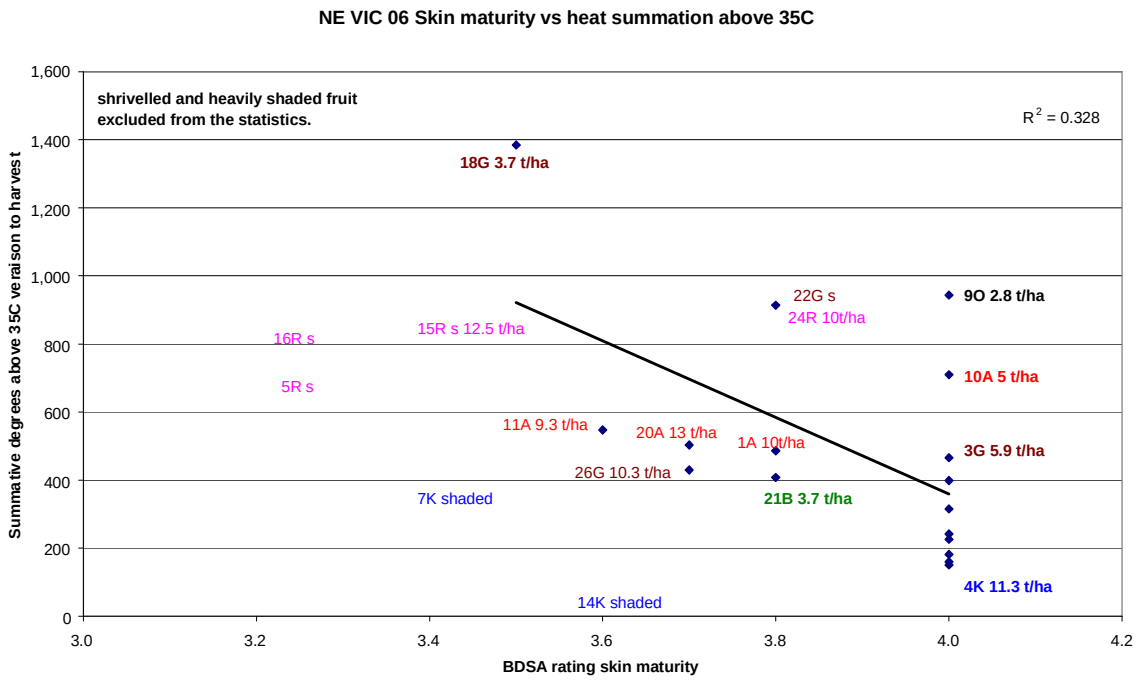


Fig. 213: In 05 there were no heat loads to speak of (note the y axis is half that of the graph for 06) and it rained on all vineyards. Here skin maturity is not exactly heat related.

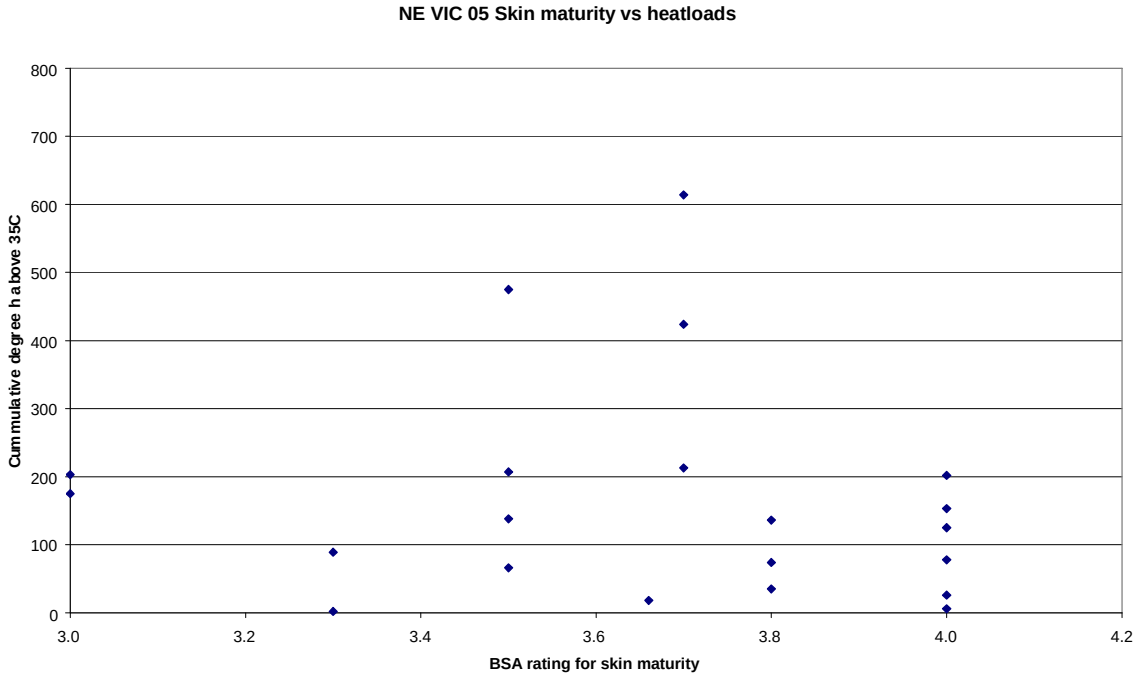


Fig. 214: When unshrivelled and unshaded berries were excluded there was a weak trend to lower BSA rating in hotter berries.

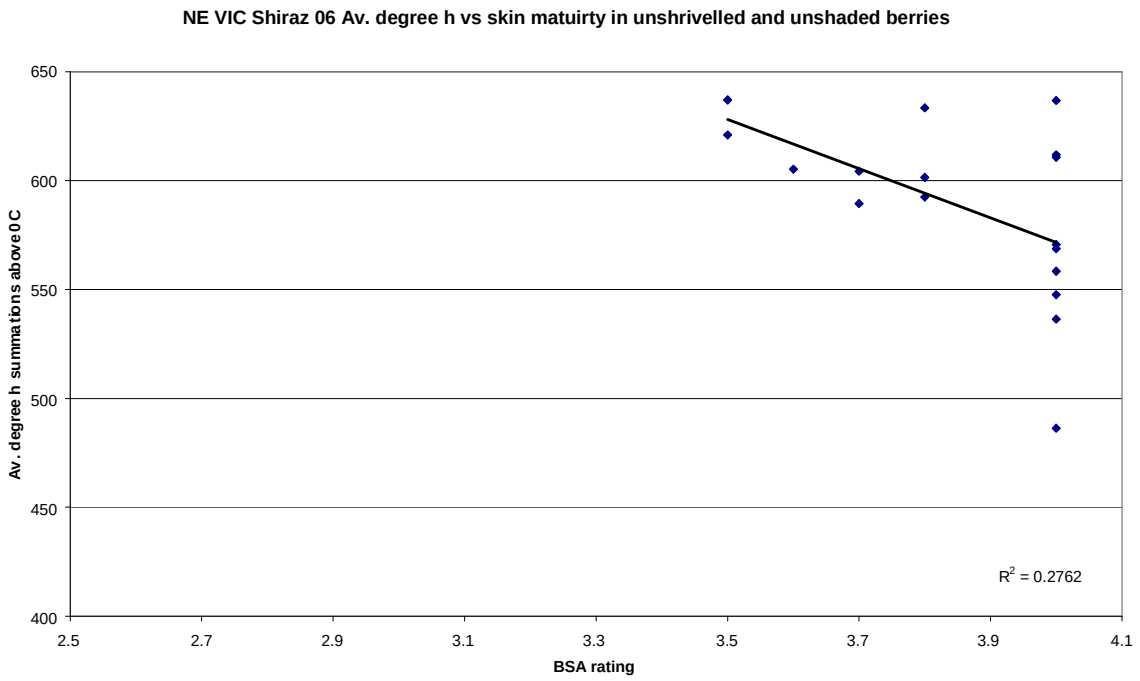


Fig. 215: In 2005 this trend was also seen but the spectrum reached into less mature skins.

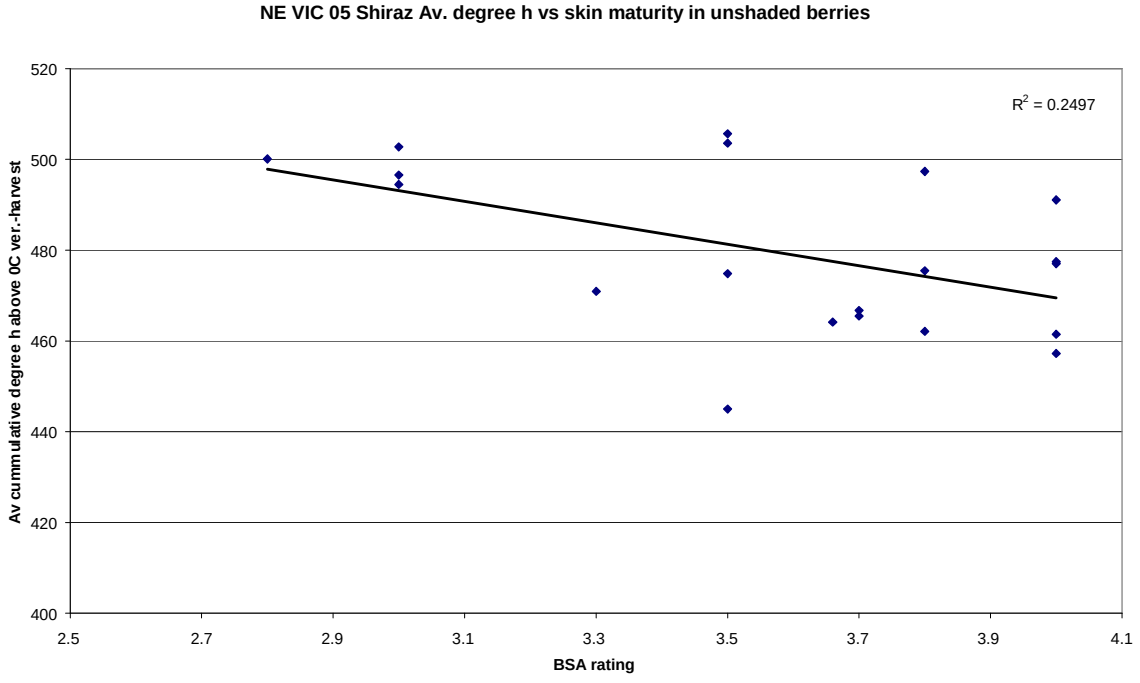


Fig. 216: BSA skin maturity was less correlated to anthocyanins in 06 than in 05, as more skin maturity this year and shrivel, heatloads and cold seemed to have a stronger influence on the lack of skin maturity than on colour at harvest.

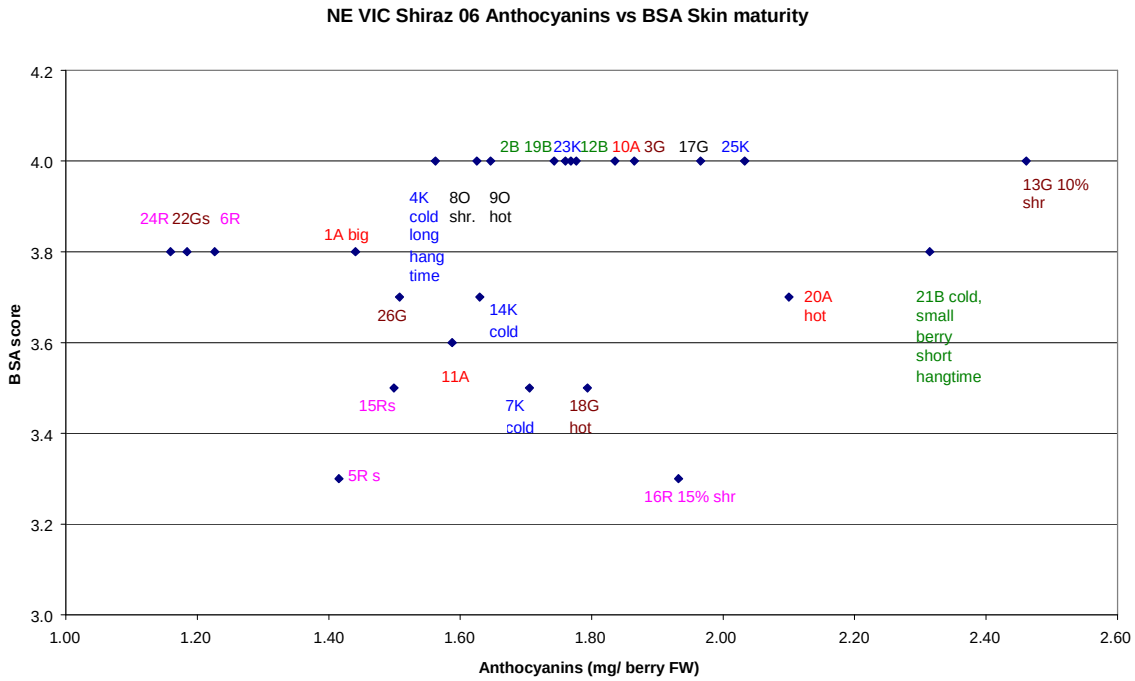


Fig. 217: BSA skin maturity vs anthocyanins in 05 were more related as berries did not experience drought (late rain) and the degradation of skin was slowed from cold and rain.

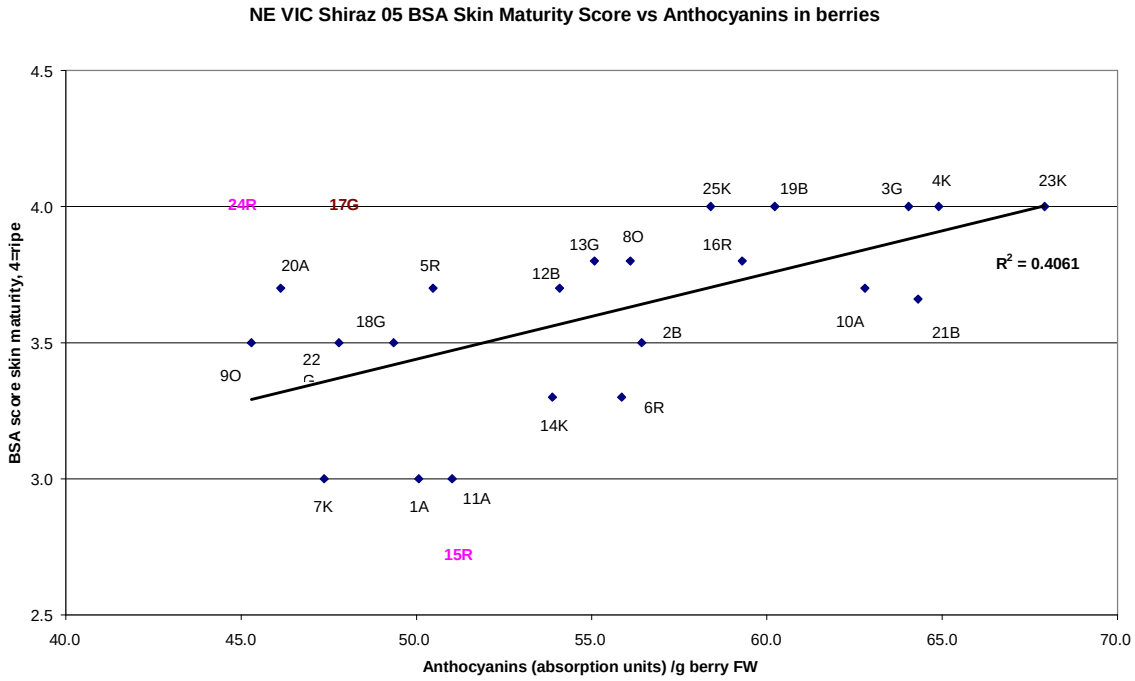


Fig. 218: On the same scale as Figure 184, seed maturity is far behind and does not reach good BSA ratings. Seed maturity correlated with none of the measured parameters.

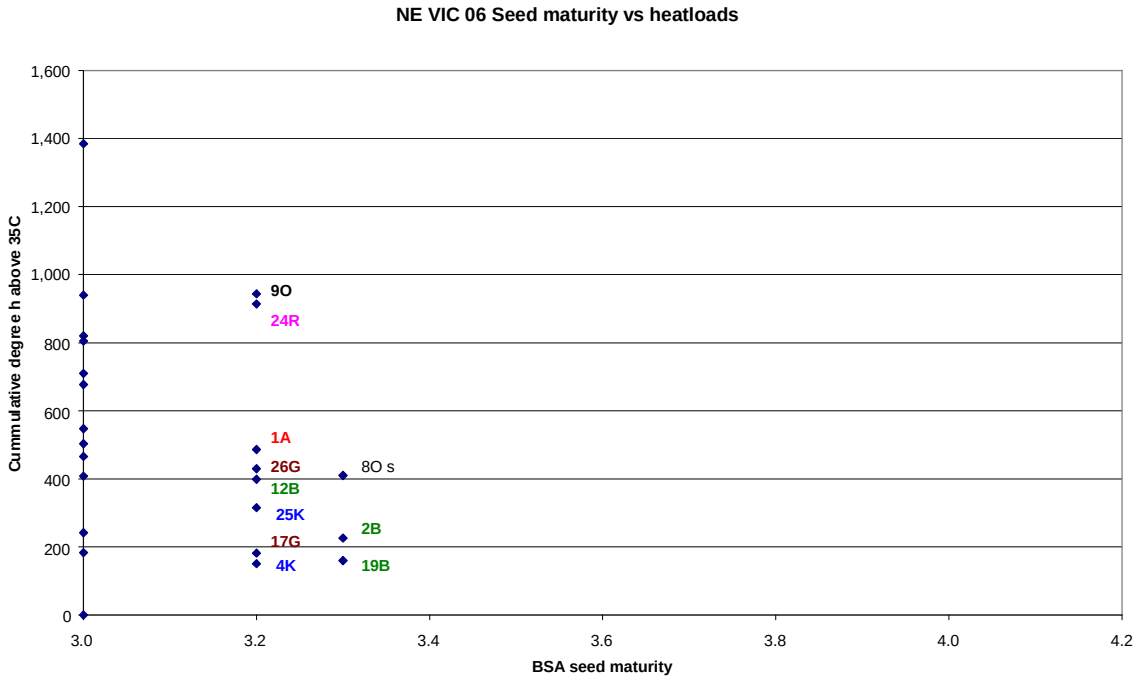


Fig. 219: Last year seed maturity was slightly correlated with the proportion of seed weight to total berry fresh weight. Seed weight was not determined this year.

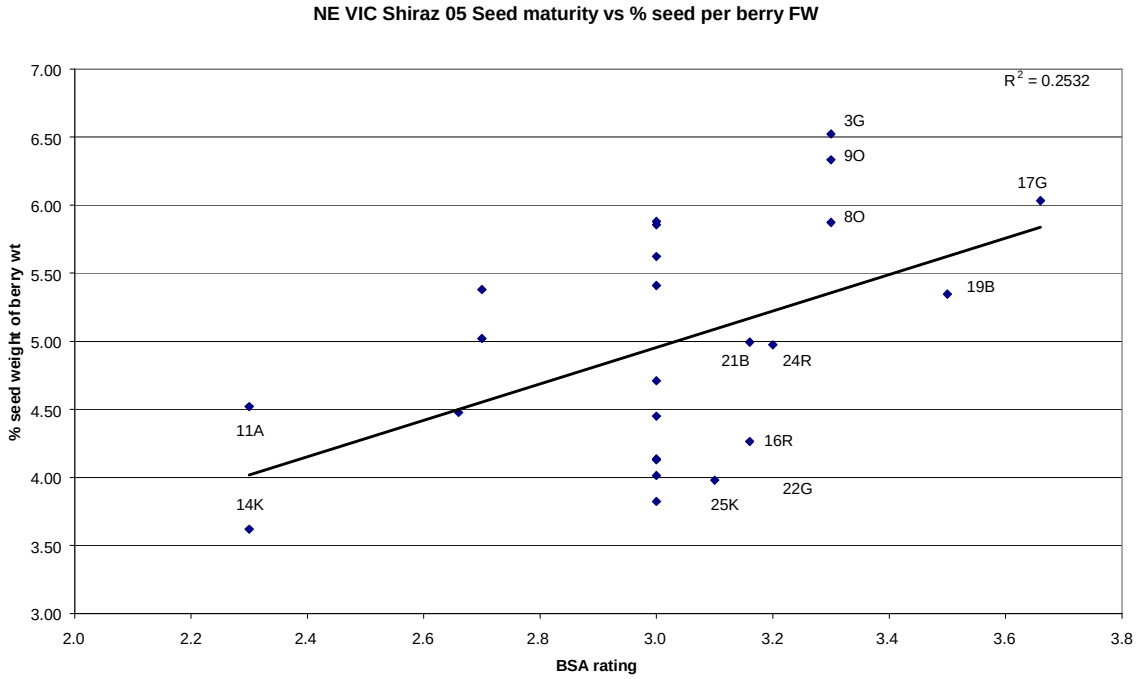


Fig. 220: Seed maturity was independent of the amount of crop on a shoot

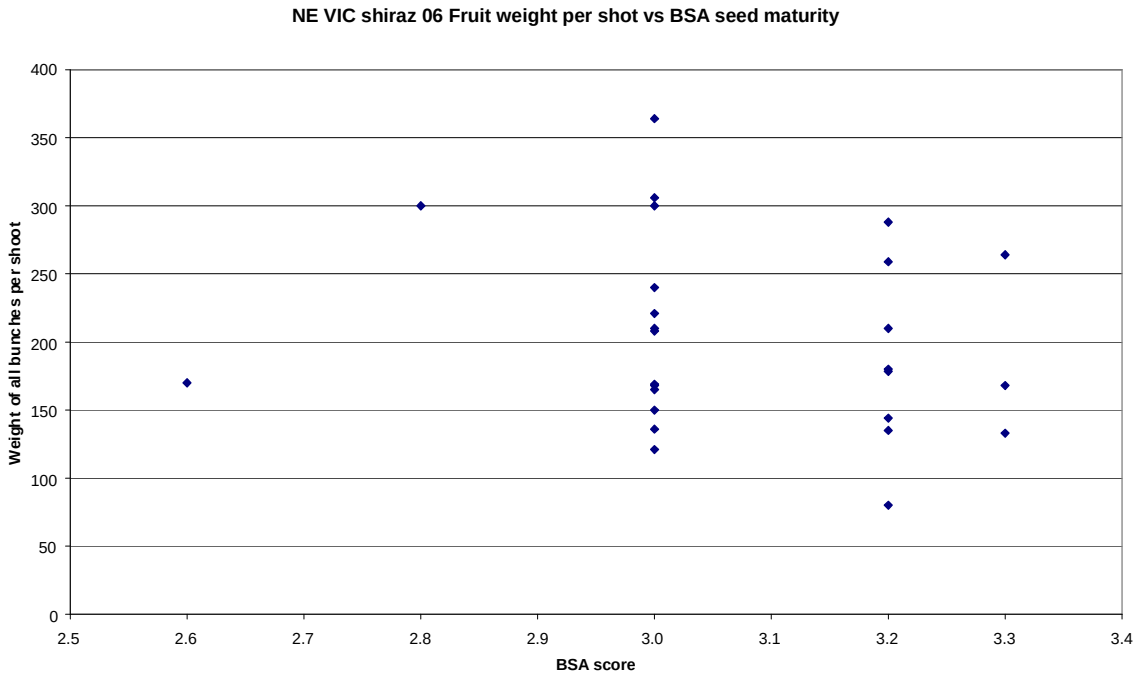


***Fig. 221*: The sum of all BSA scores reflect the average temperature summations base 0C. In 06, cooler averages seem to reach better BSA values.**

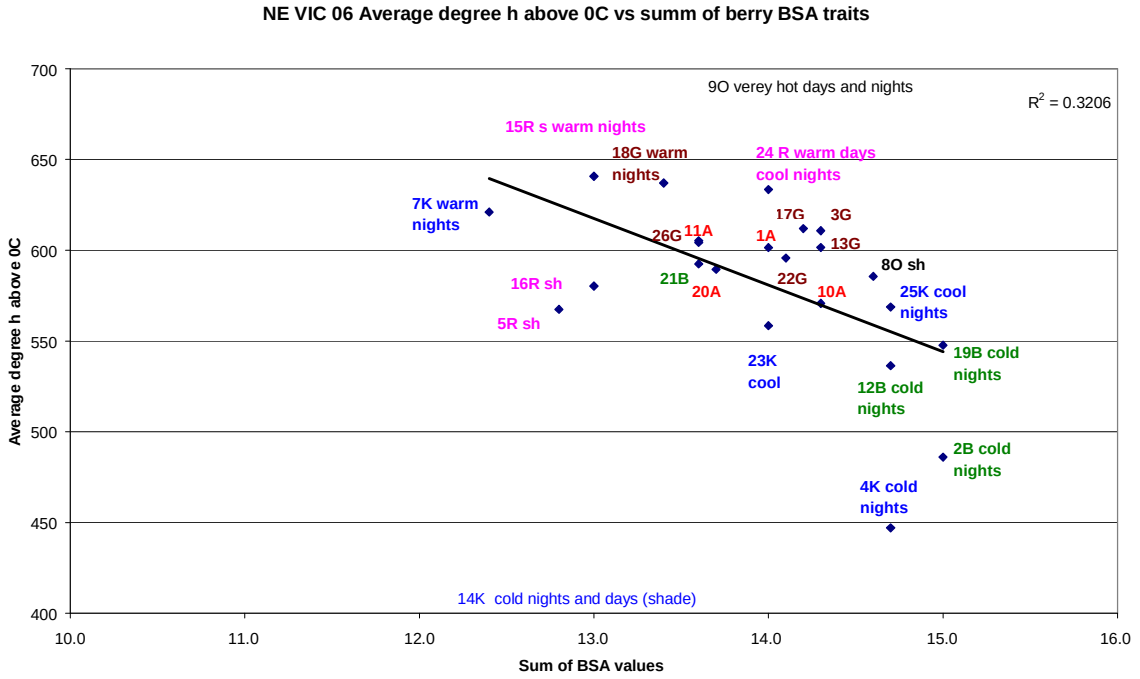


Fig. 222: **The relationship between average heat summations and BSA is much better revealed when the seed values are not counted and when all shrivelled berries are deleted. Hotter bunches have lower scores.**

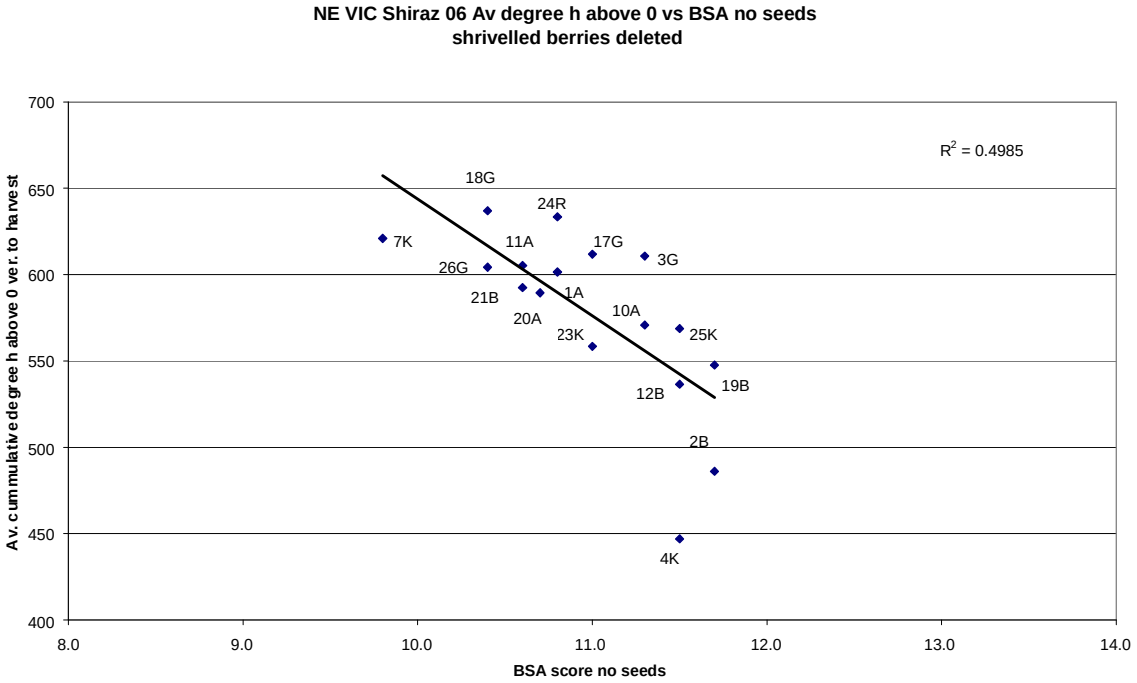
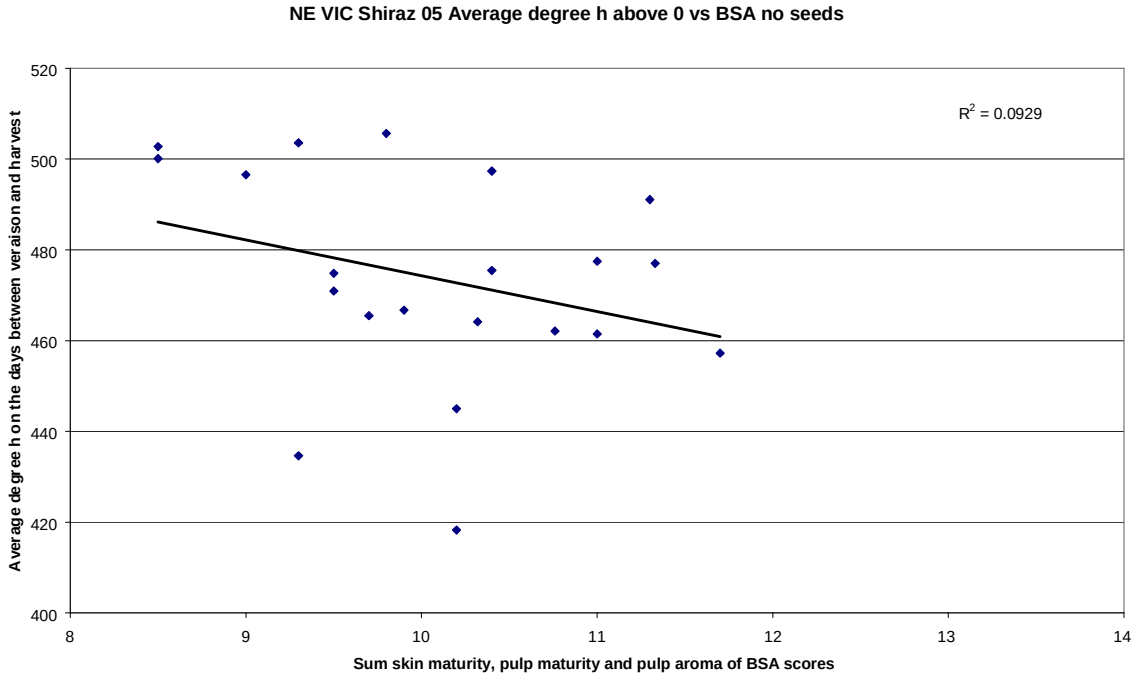


Fig. 223: The relationship between heat loads and BSA (seeds excluded) is less expressed in a year with fewer heat loads and lower bunch zone temperatures through leaf management.



Synopsis of berry chemistry and bunchzone temperatures

Fig. 224: **Berry anthocyanin and phenolics, bunch exposure to morning or afternoon sun from temperature curves, leaf layers, hangtime and heatloads.**

Like last year, best anthocyanins were only obtained (in unshrivelled berries) with a combination of good morning sun exposure, and few afternoon heatloads. Long hangtimes only improved the result in cools climates with good bunch exposure. The relationship is less expressed for phenolics this year as seeds were ground up in the extract.

Location	Anthocyanin 06 (mg/g berry FW)	Total Phenolics (mg/g berry FW)	Bunch heat loads Morning	Bunch heat loads Afternoon	Leaf layers East or south	Leaf layers West or north	Hang Time (days ver.-harv.)	Hours above 35C
1A	1.4	4.6	+	++	1.5	2.1	40	486
2B	1.7	7.5	+	-	0.8	1.4	54	266
3G	1.9	5.3	++	+	0.8	3.1	37	466
4K	1.6	4.4	--	-	1.8	0.9	67	151
5R 5%S	1.4	6.4	+	++	2.2	2.1	42	677
6R	1.2	4.1			2.7	3.5		na
7K	1.7	5.7	+	+	1.2	1.6	34	379
8O 5%S	1.6	6.6	+	+	1.6	1.9	36	410
9O	1.6	8.3	+	++	0.7	1.7	41	944
10A	1.8	6.3	++	+	0.6	3.1	31	710
11A	1.6	5.2	+	++	1.5	2.5	40	547
12B	1.8	5.0	+	++	0.9	1.4	39	399
13G 10%S	2.5	12.5	-	-	1.0	1.2	40	183
14K	1.6	3.1	--	--	0.8	3.2	60	0
15R 5%S	1.5	4.4	+	++	2.8	1.6	39	805
16R 15%S	1.9	11.1	+	++	1.7	0.9	42	820
17G	2.0	5.0	++	+	1.2	1.7	26	182
18G	1.8	6.5	+	++	1.2	1.8	47	1385
19B	1.8	5.5	++	-	0.8	1.4	44	160
20A	2.1	7.1	++	+	1.8	1.5	46	503
21B	2.3	8.1	++	+	1.5	1.3	32	408
22G 5%S	1.2	5.1	+	++	2.9	2.6	46	940
23K	1.8	5.4	++	-	1.5	2.2	39	242
24R	1.2	4.2	++	++	2.2	2.2	54	914
25K	2.0	7.5	++	+	1.2	2.1	39	315
26G	1.5	4.6	++	+	1.2	2.7	40	430

Wine Chemical Analysis

Tab. 4 Shows a synopsis of berry and wine traits in young wine sampled immediately after pressing.

Correlation of grape and wine colour and phenolics

Fig. 225: There is some relationship between berry and wine anthocyanins.

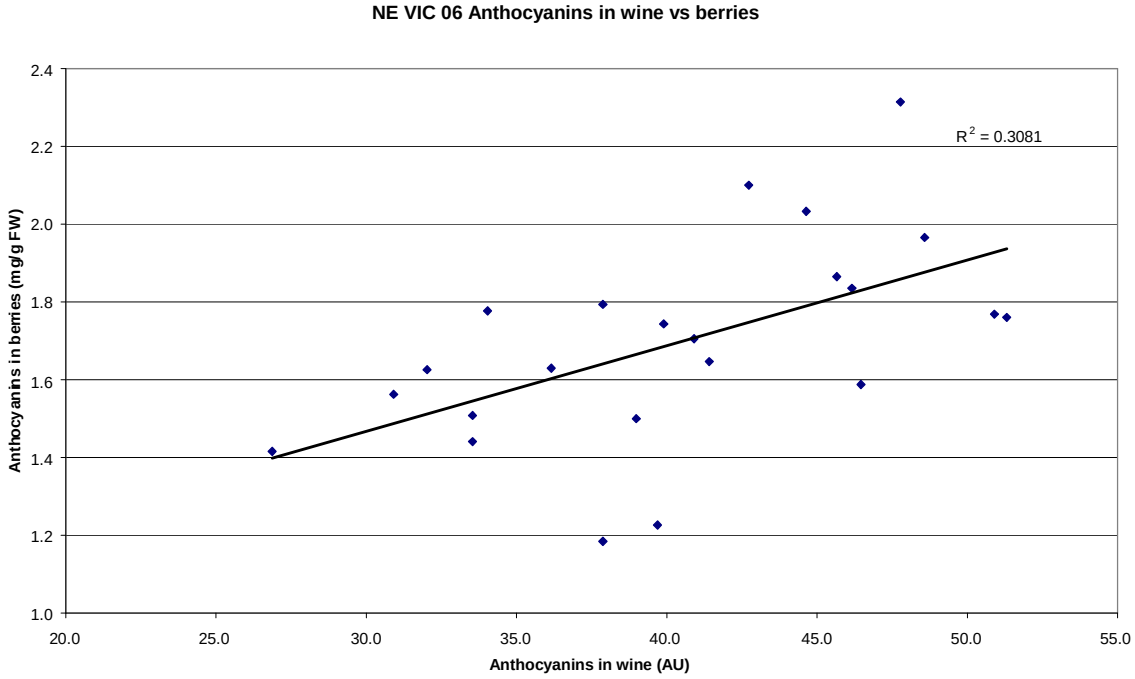


Fig. 226: This trend was similarly present last year.

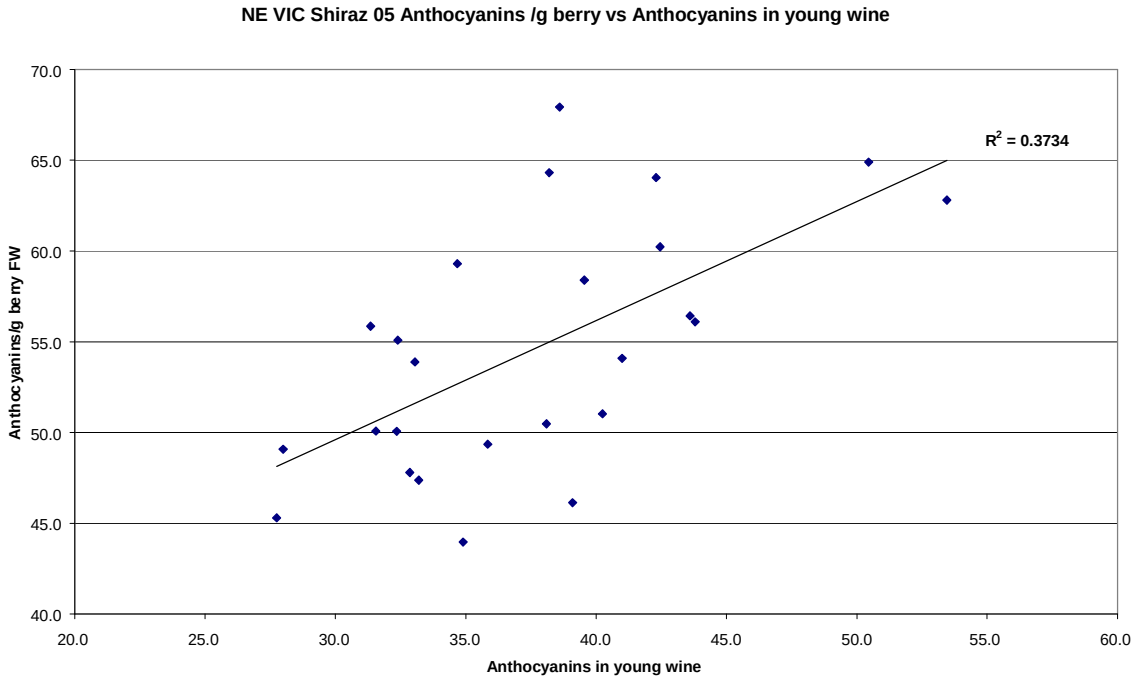


Fig. 227: There is no relationship between berry and wine phenolics which may be caused by the grinding of the seeds in the berry extract, by high proportion of skin per berry fresh weight in shrivelled and / or very small berries (13G, 5R, 8O, 2B) and by winemaking practice (eg runoff and long skin extraction 3G).

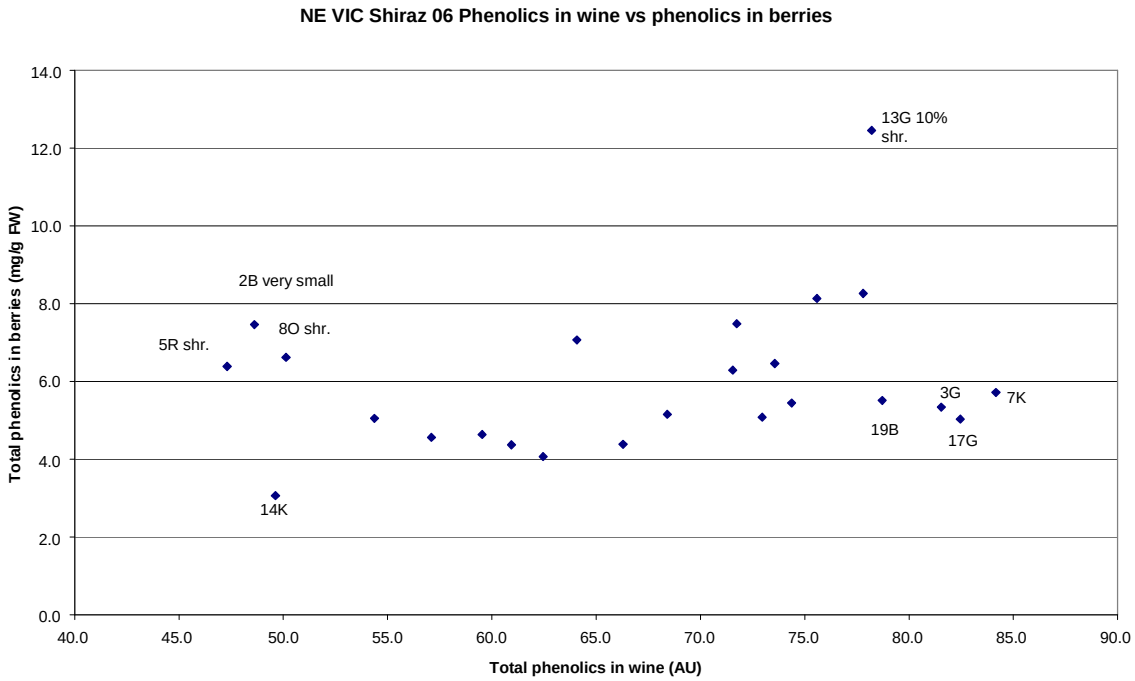


Fig. 228: Last year there was a trend that very high phenolics in berries also resulted in very high phenolics in wine.

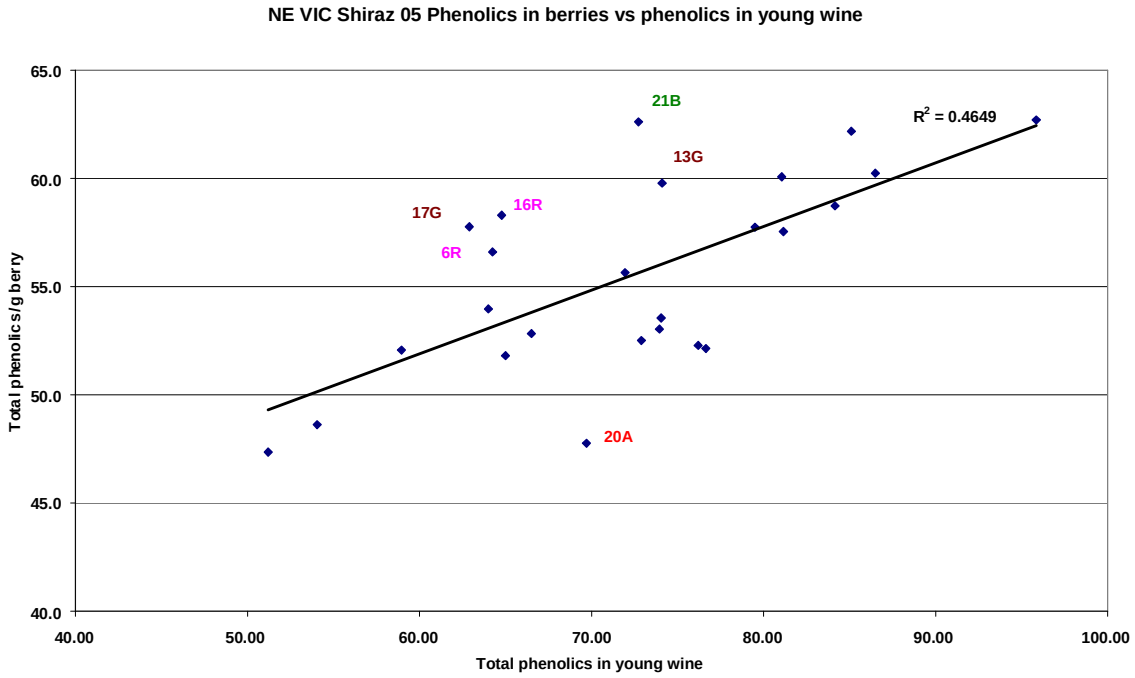


Fig. 229: This year phenolics in young wine did not correlate with skin maturity rating

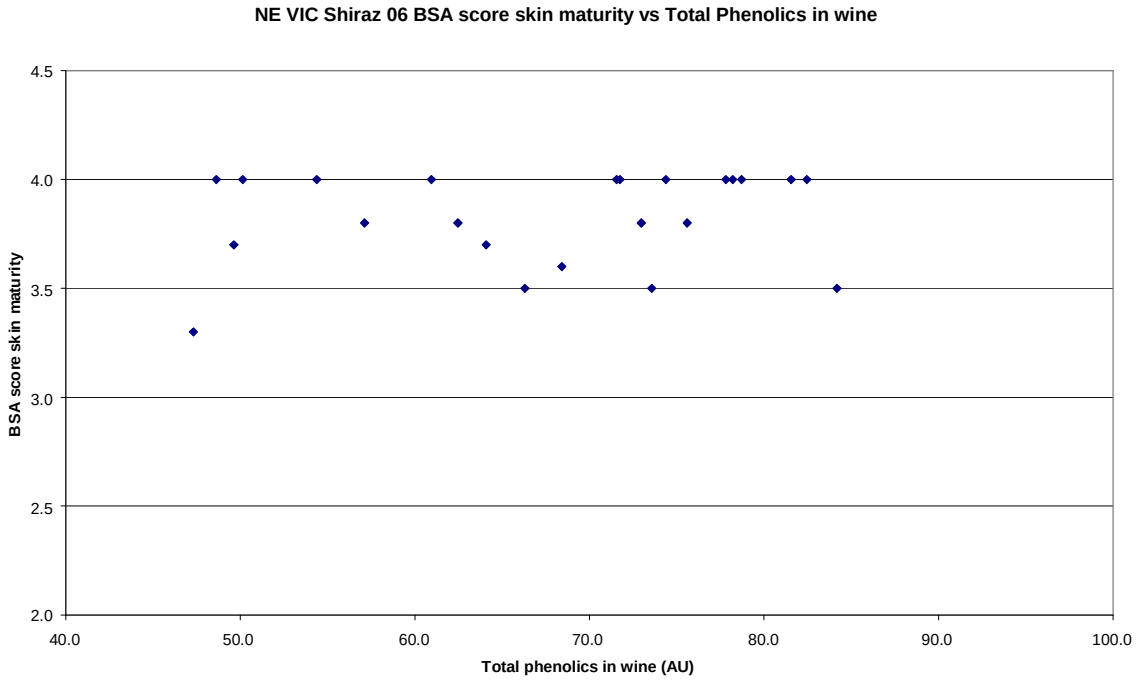
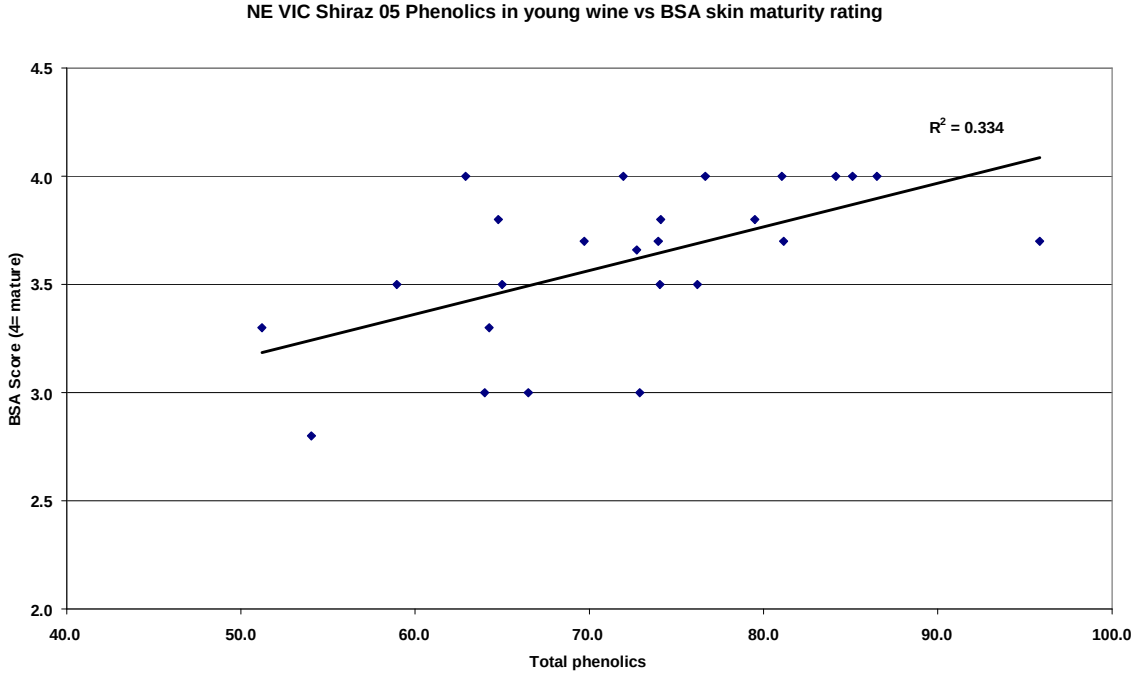


Fig. 230: Last year when there were less extremes (shrivel, shade etc) there was a trend that unripe skins released lower phenolics in wine.



Winemaking practices

Winemakers provided information about the processes involved from harvesting to end of fermentation (**Tab 6**). Last season determining factors for wine taste and mouthfeel were time on skins and fermenter type.

Fig. 231: There was a trend that longer time on skin played a role for wine colour but the relationship was not significant this year.

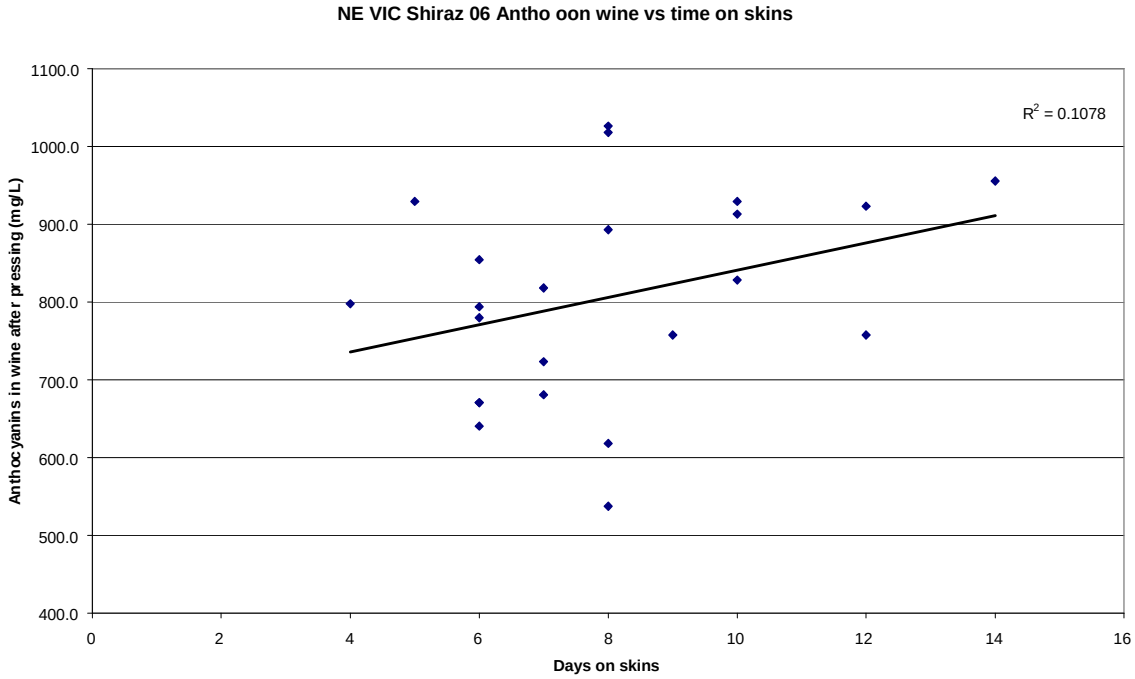
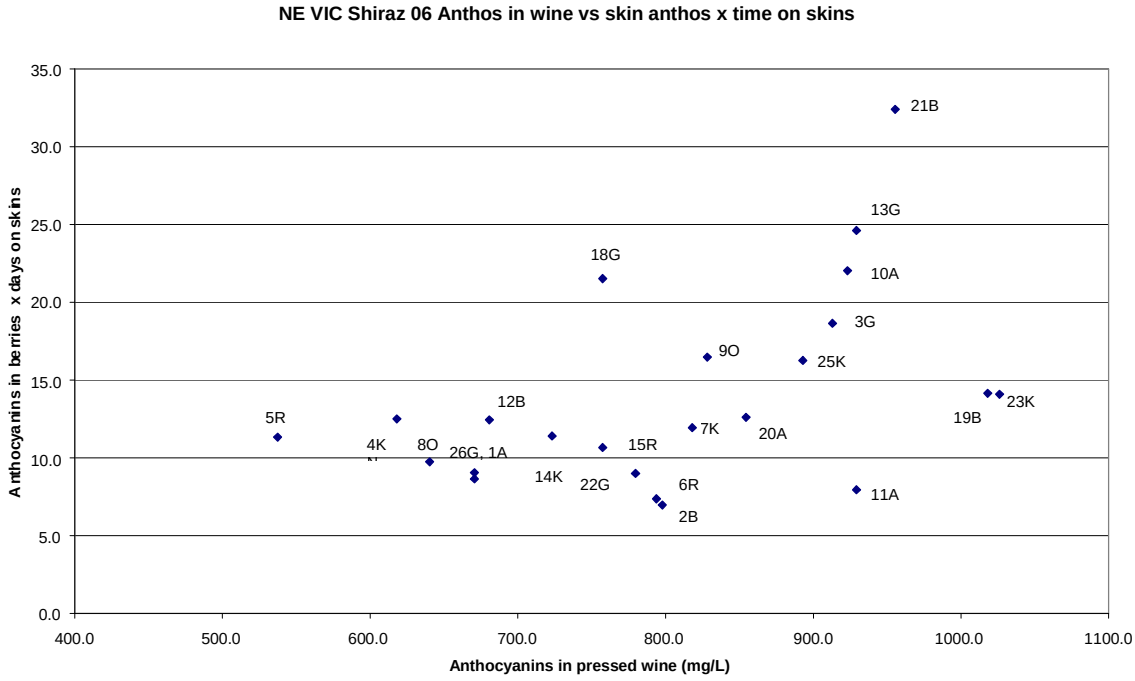


Fig. 232: This year as there was a large variation of anthocyanins in berries; these values were multiplied with time on skin. It became obvious that more of each does not linearly lead to more colour in wine.



Wine assessments

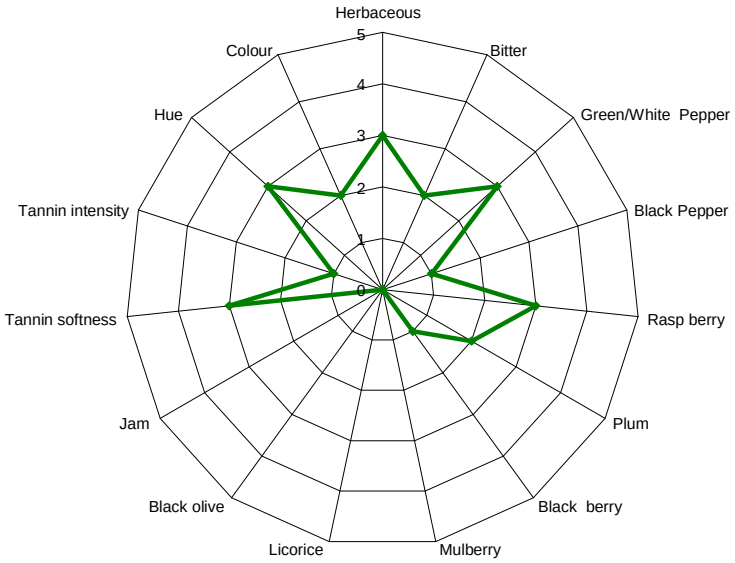
This year many wines were less advanced and had some problems related to the fact that they were not finished (see tasting notes Tab. 7).
Winemaking practices were very diverse (see Tab. 6) and had also some influence on wine scores and descriptors. An example seems to be 20A : The vineyard has an acceptable vine balance with high fruit load but also high leaf area (Tab.2) The fruit zone is warm (average 589 degree h above 0C (Tab. 3), has warm fruit in the morning, no heatloads in the afternoon (Tab. In Fig. 224), average hangtime and good berry chemistry (Tab. 4) is rated highly for BSA of pulp and skin (Tab. 5) thus should yield good fruit aromas and soft tannins BUT gas high additions of tannins and oak so is at this stage rated poorly for tannin softness and red fruit flavours. The addition of 10% Viognier may have resulted in the strawberry aroma tasted by the judges. This wine may evolve into more softness with time, and site condition and growing practices are not reflected by wine score (Tab.7).

In many wines there was an interesting correlation between growing practices and wine tasting descriptors.
A good example is vineyard 2B on a cold plateau with average degree h above 0C of 486 (cool). It's wine is herbaceous (high TA not high Be), has white pepper notes (only possible in early season or cool areas), early season or cool climate fruit descriptors (raspberry) and due to a long hangtime and ripe skins it displays high tannin softness.
In contrast, 21 B is a warmer vineyard with average degree hours above 0C of 592 (warm to hot) with exposed fruit due to basal leaf loss and exhibits plum and cooked flavours in the wine, less soft tannins (heat stress) and high colour (possibly due to short hangtime and small berry size).

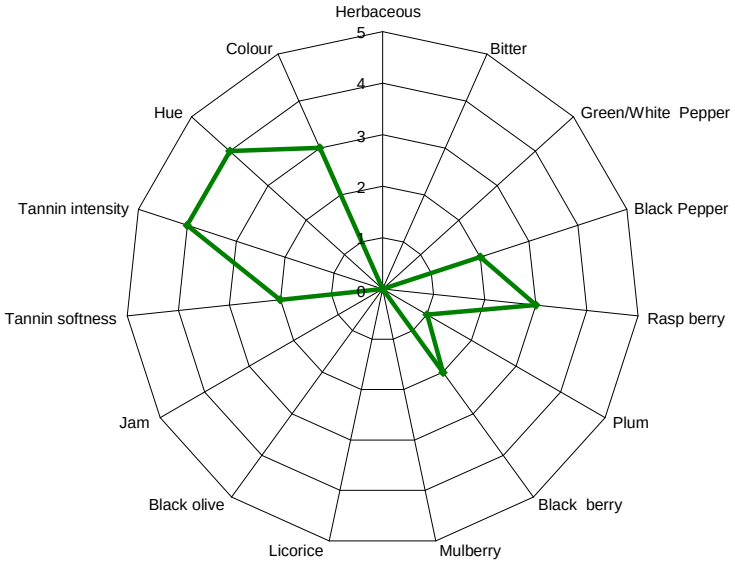
The spider diagrams below are deliberately sorted by regions and show that within a region very different wines can be produced.

Fig. 233: Spider diagrams of taste descriptor scores for the young wines (Tab. 7)

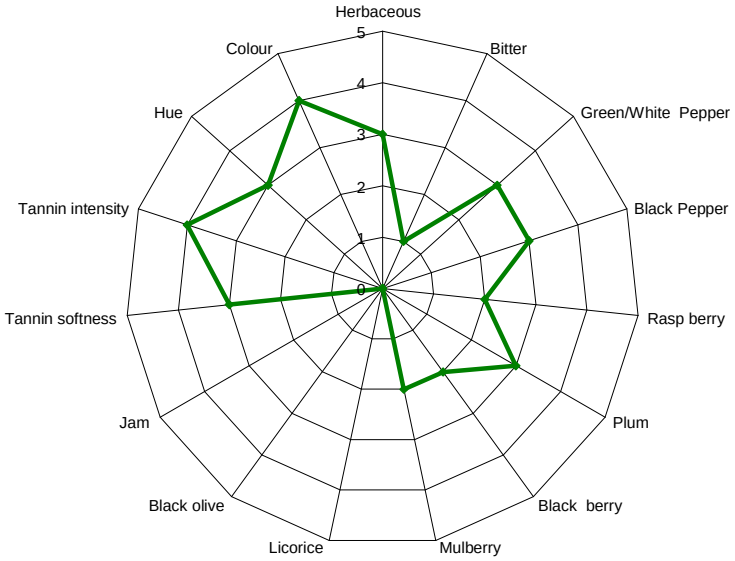
2B



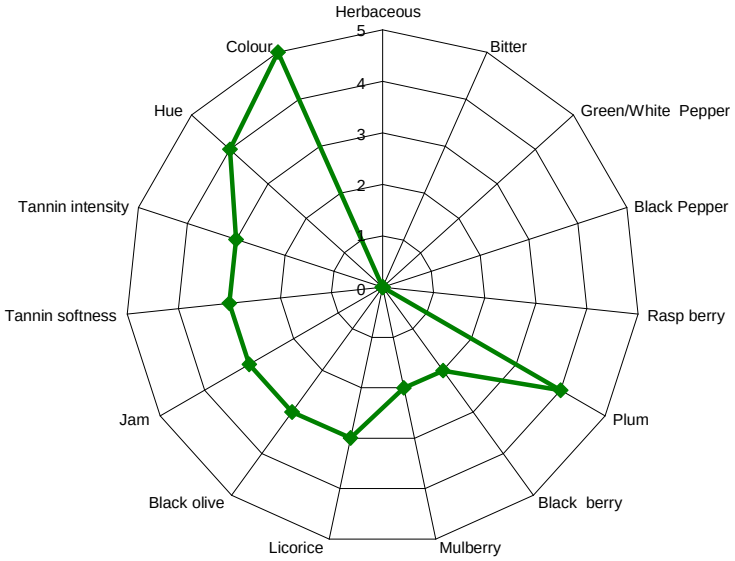
12B



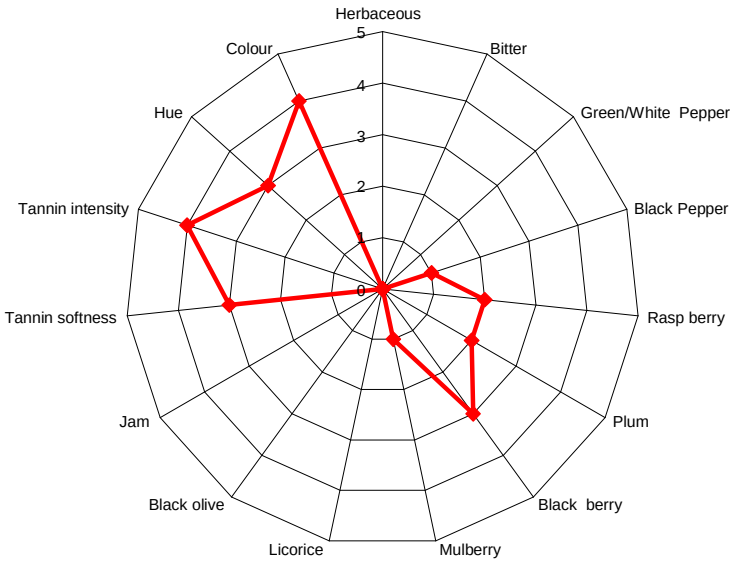
19b


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
5
4
3
2
1
0

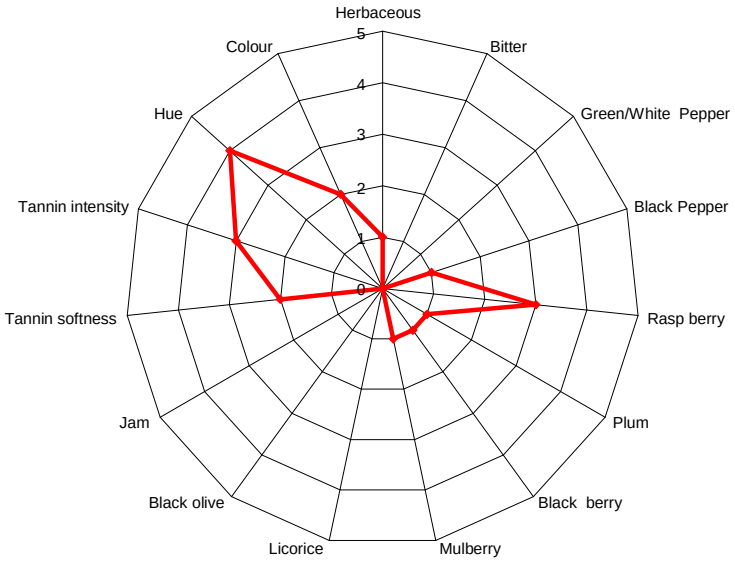
21B


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
5
4
3
2
1
0

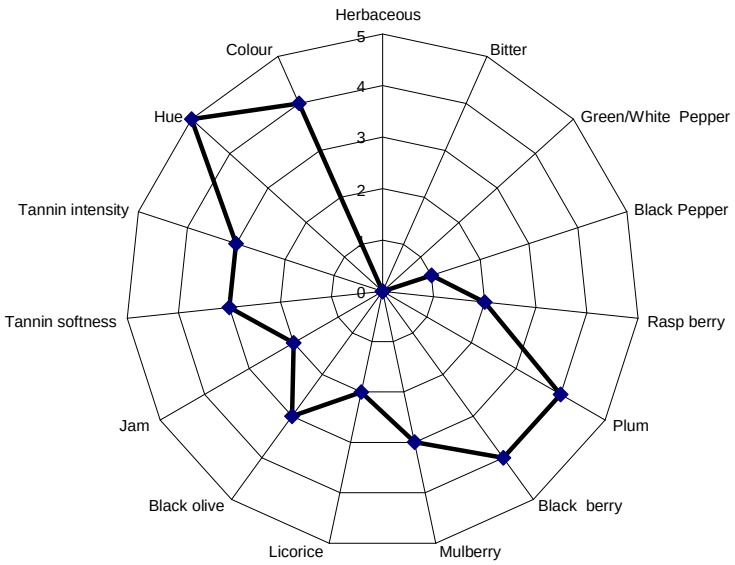
10A


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
5
4
3
2
1
0

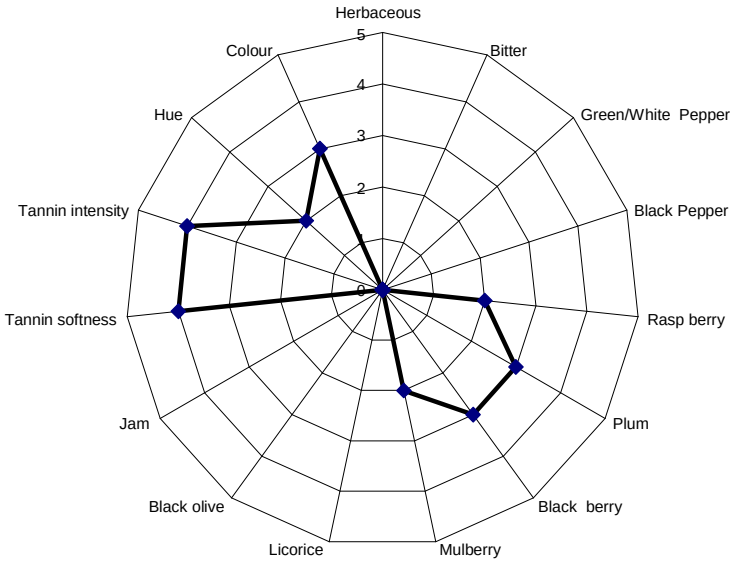
20A


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
5
4
3
2
1
0

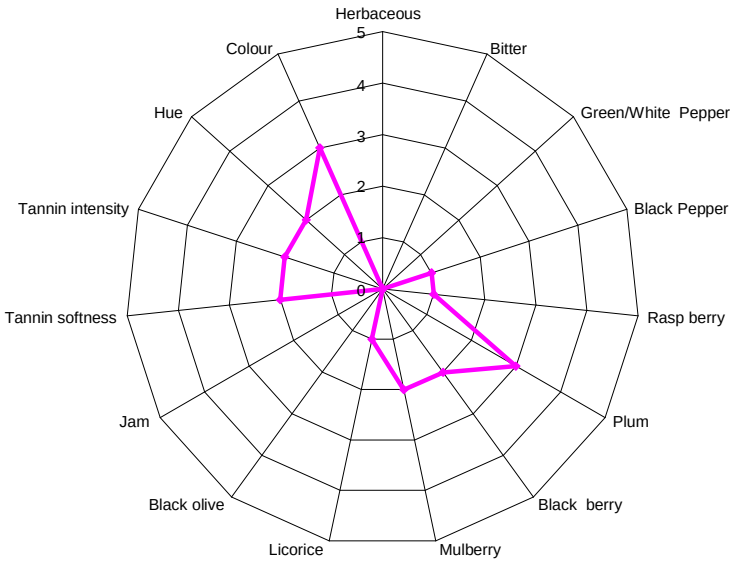
8O


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
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4
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2
1
0

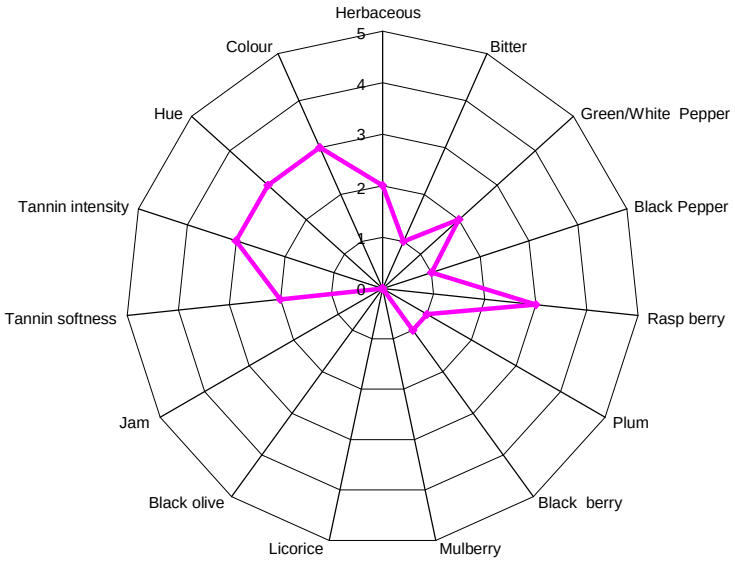
9O


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
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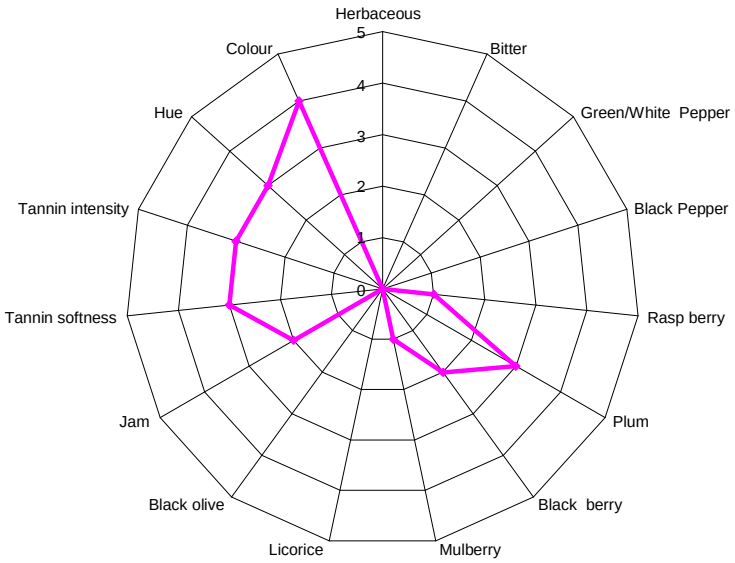
5R


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
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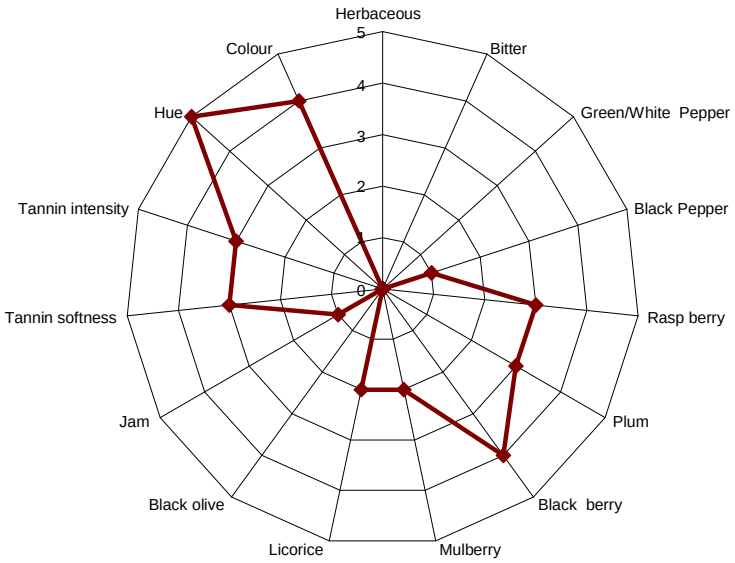
6R


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
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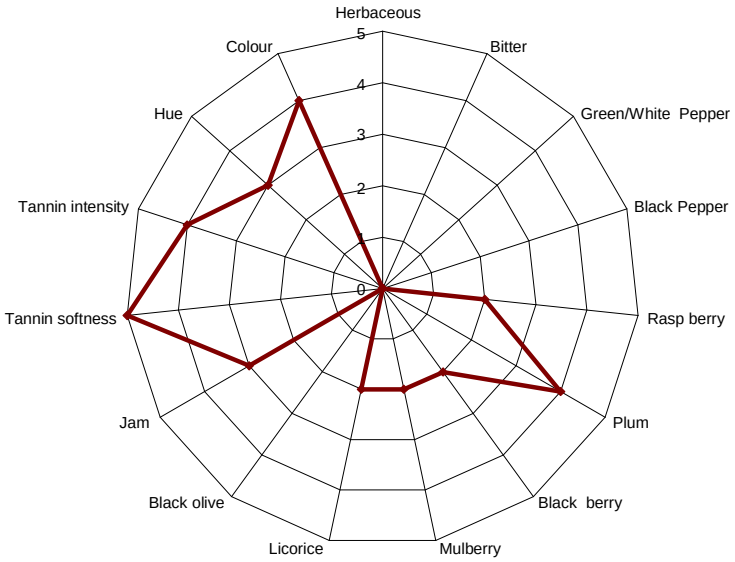
16R


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
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4
5

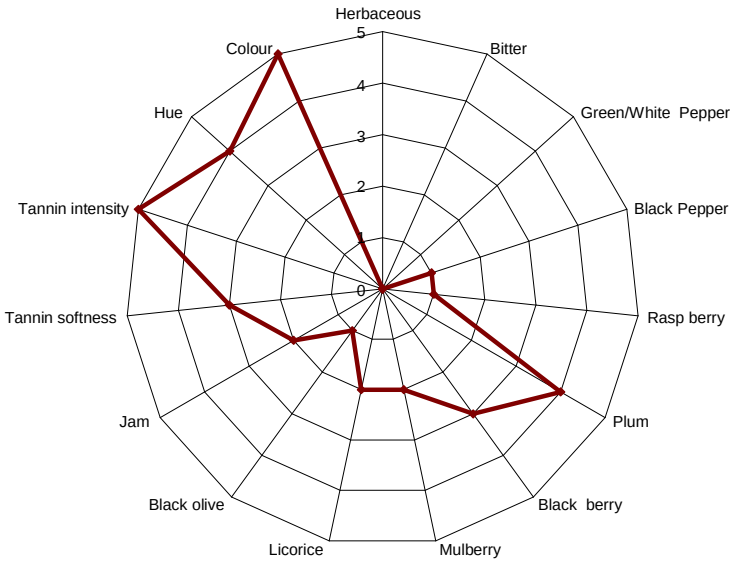
3G 16.5


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
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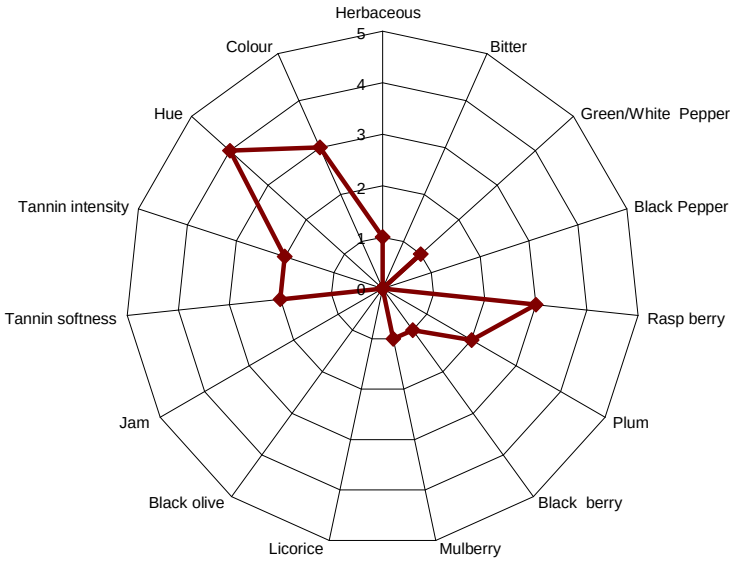
13G


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
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Colour
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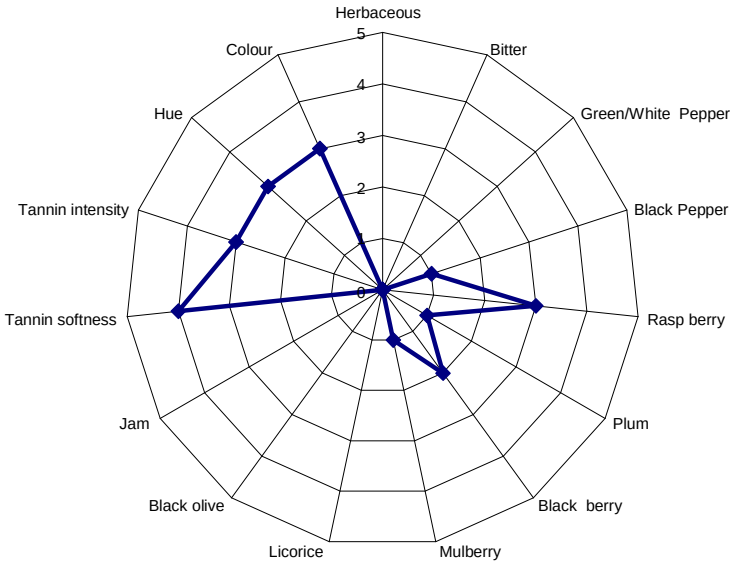
17G


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
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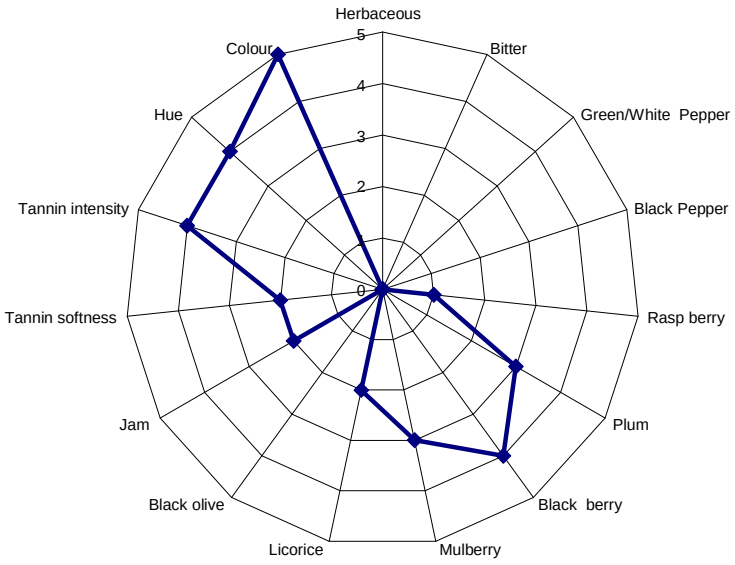
22G


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
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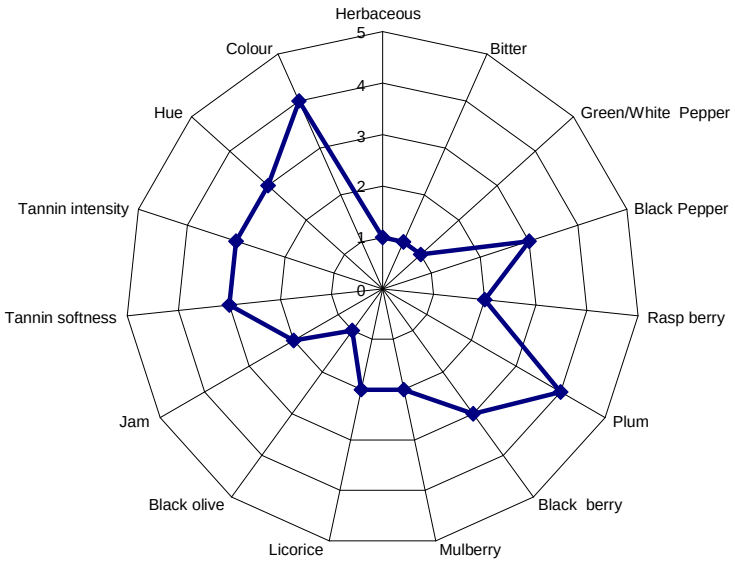
4KN 17


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
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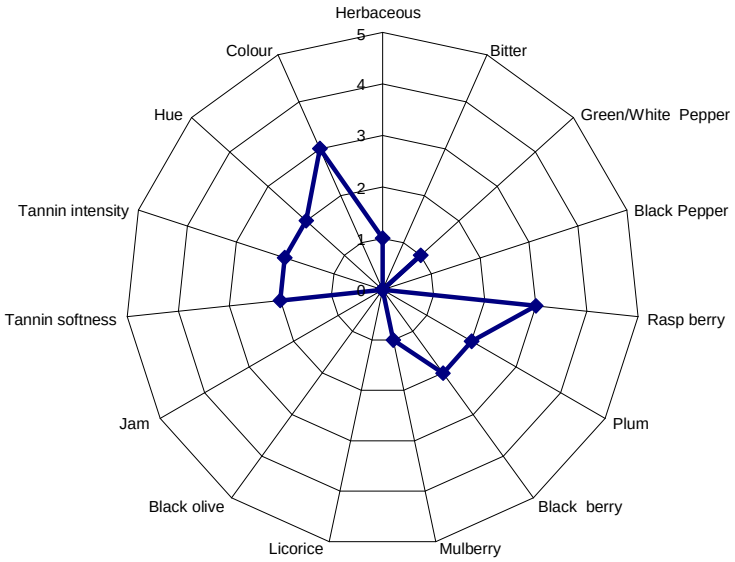
7K 16.5


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
5
4
3
2
1
0

23K


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
5
4
3
2
1
0

25K


Herbaceous
Bitter
Green/White Pepper
Black Pepper
Rasp berry
Plum
Black berry
Mulberry
Licorice
Black olive
Jam
Tannin softness
Tannin intensity
Hue
Colour
5
4
3
2
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0

Wine scores

Red fruit (Raspberry, Plum, Blackberry, Mulberry) but not jammy fruit was a sought after trait in the young wines.

Fig. 234: Total scores depended strongly on the sum of red fruit rating

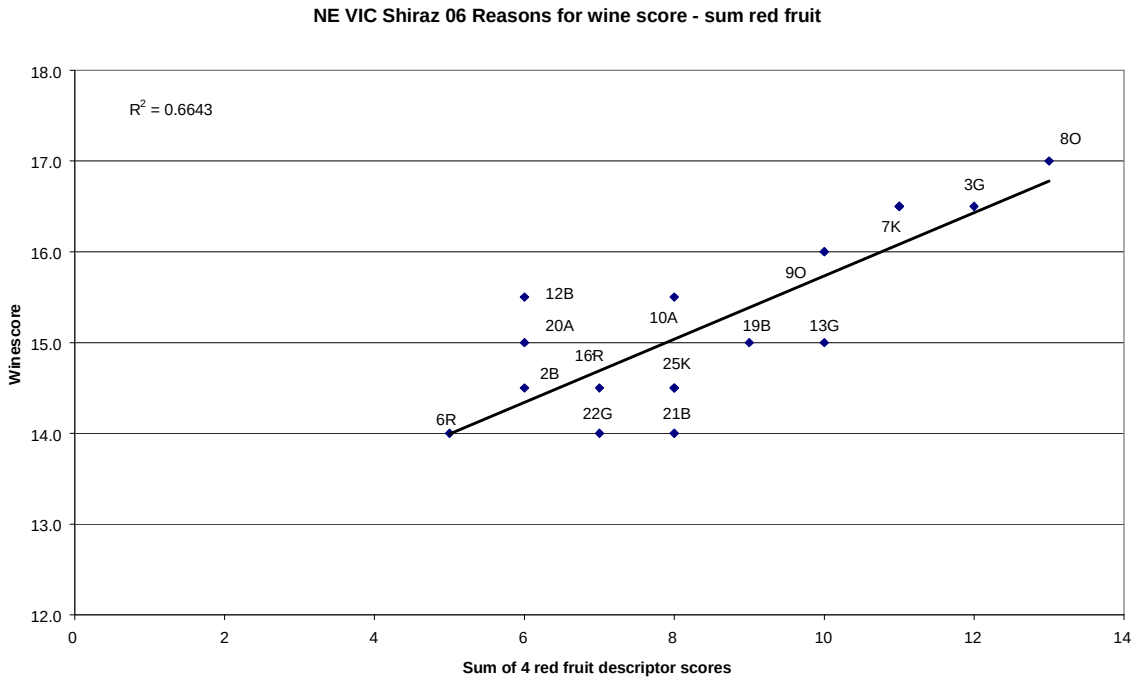


Fig. 235: Wine scores depended less on colour and very little on tannin softness (not shown, influence of oak additions).

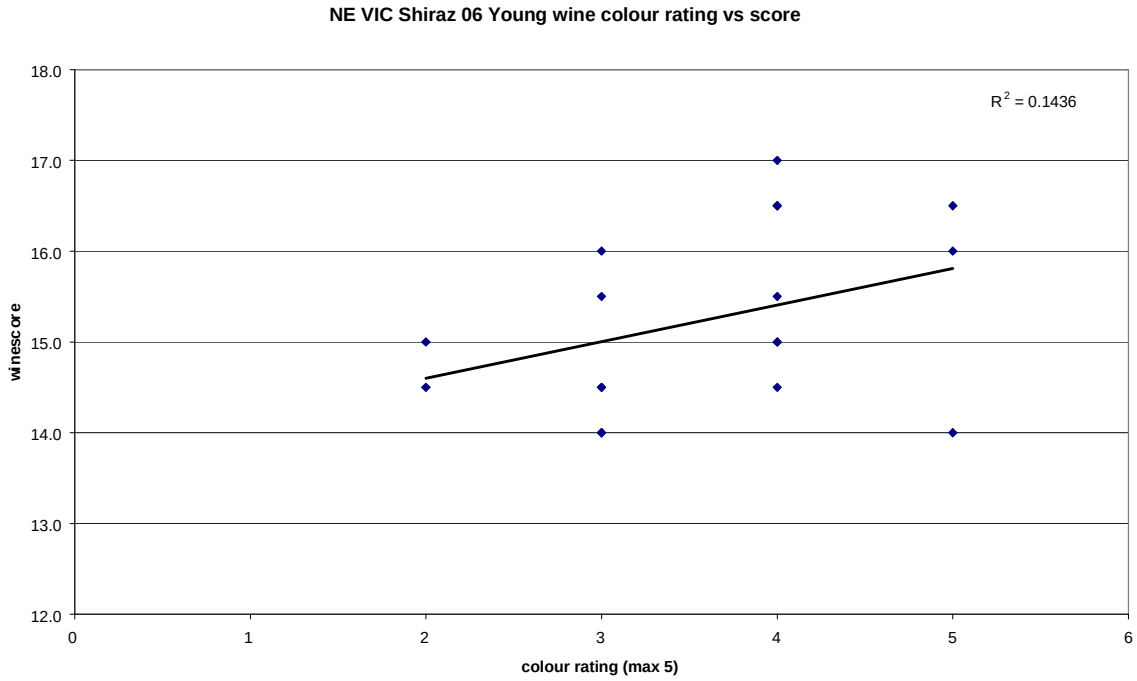


Fig. 236a: The slower the sugar accumulation was the lower the wine score. Very hot and very cold fruit have low sugar increases per day.

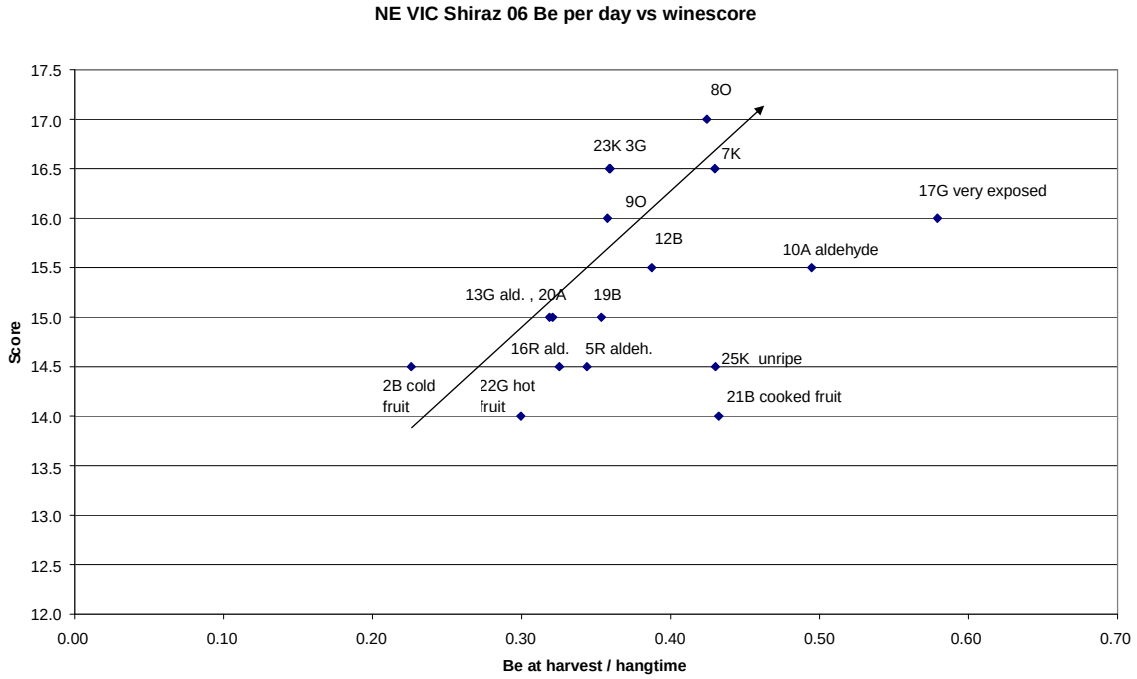


Fig. 236b: Last year sugar accumulation per day was slow for most vineyards.

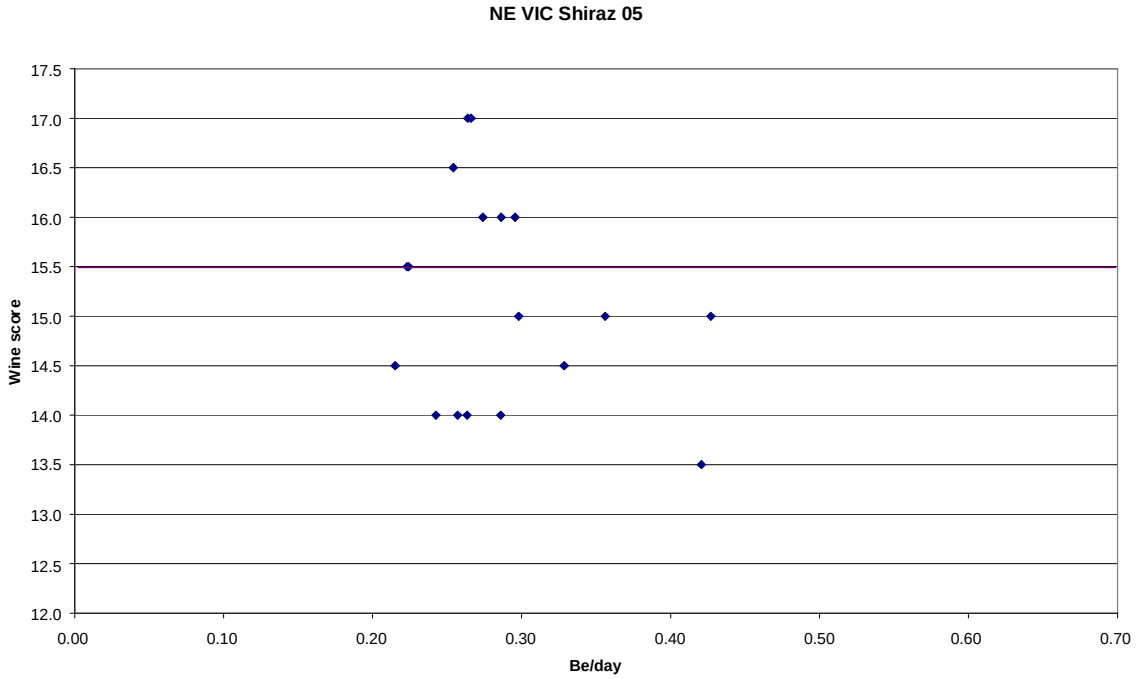


Fig. 238a: In 2006, with higher amounts of cumulative degree h the chances of achieving high red fruit scores diminished. Left of the arrow are fruit with very short hangtimes.

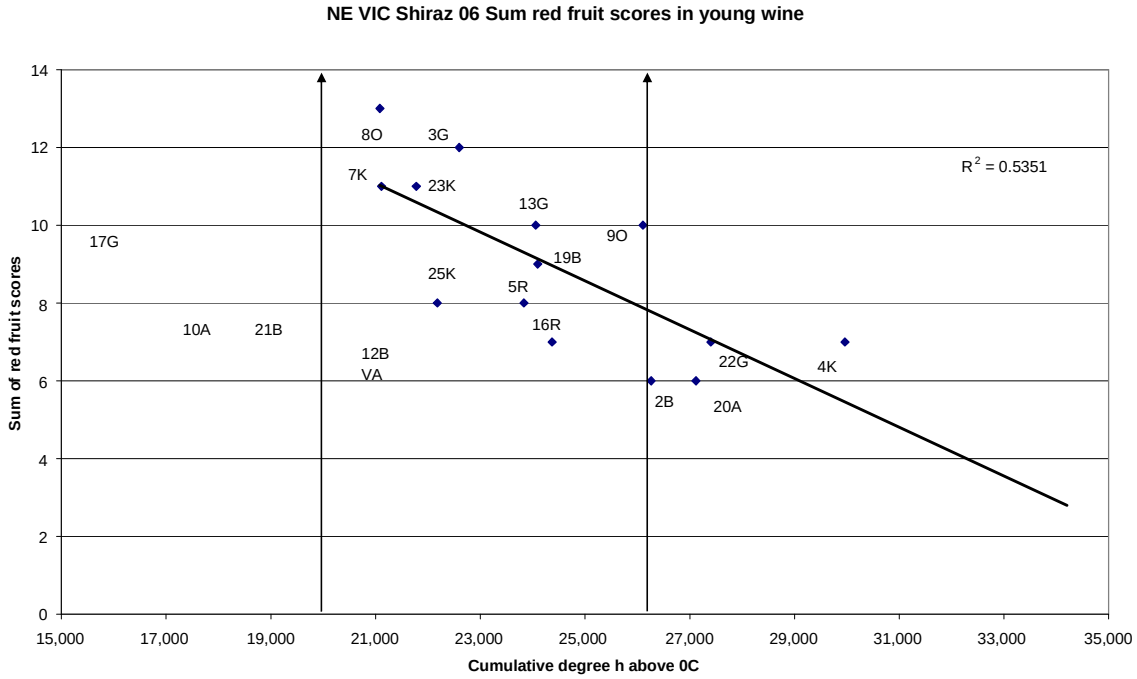


Fig. 238b: In 2005, a colder year, some wines have low fruit aromas, being in a colder cumulative temperature bracket (exception R6 and R 16 with wine faults). Best fruit aromas are reached at higher cumulative degree hours (due to colder nights) from where a drop in fruit aroma also occurs with higher heat loads.

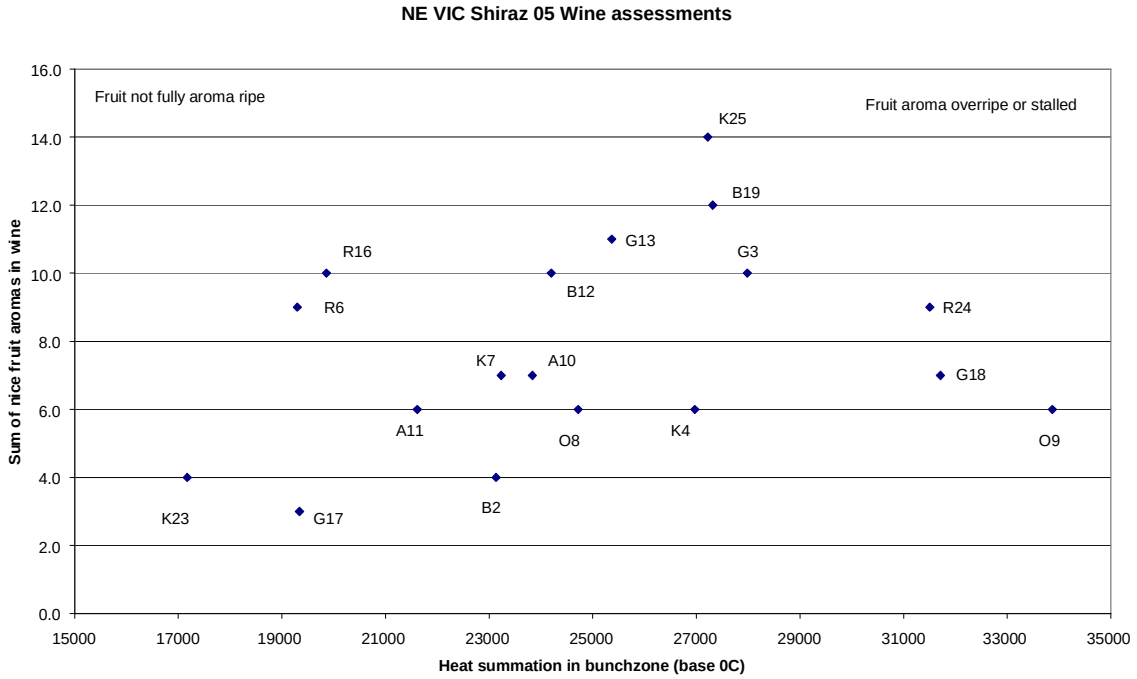


Fig. 239a: In 2006, with higher amounts of cumulative degree h and no drought stress the chances of having softer tannins in the wine may increase.

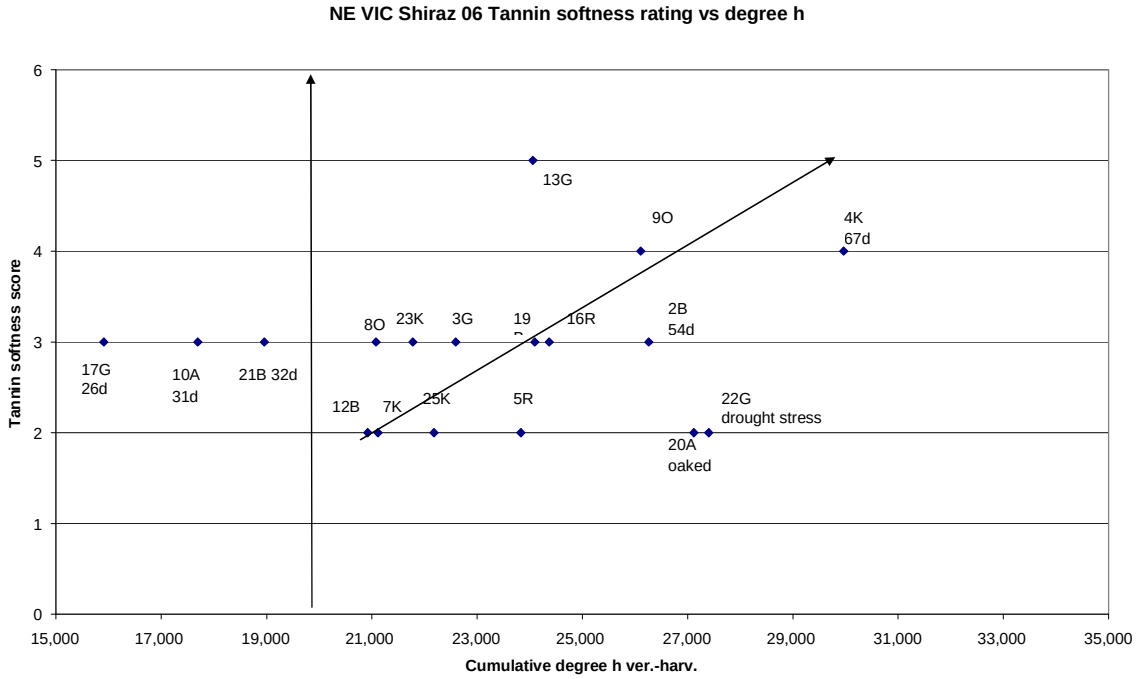


Fig. 239b: In 2005, the cooler year, there is a linear relationship between cumulative degree h and tannin softness rating in wine (exception fruit with heatloads (9, 18, 24).

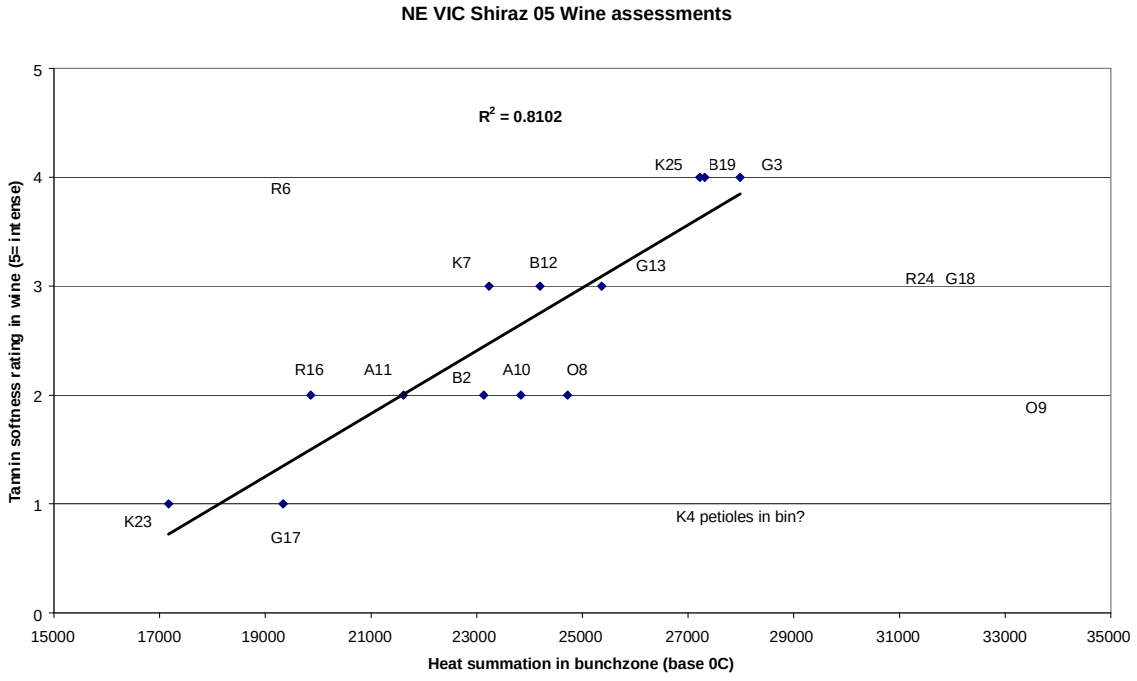


Fig. 240a: This year which was considerably hotter, wine scores above 15.5 were reached between 20,000 and 26,000 degree h in the absence of problems. Vineyards 5, 13, 16 and 19 had visible water stress. Vineyard 25 had too many leaves per fruit and was harvested too early due to excessive sugar ripeness. Below 20,000 degree h came about with very short hangtimes and above 26,000 degree hours were accumulated in bunchzones where the fruit had long hangtimes that did not improve the scores except for 4K which is a cold site. It may be noted that many wines have reached higher scores than the year before.

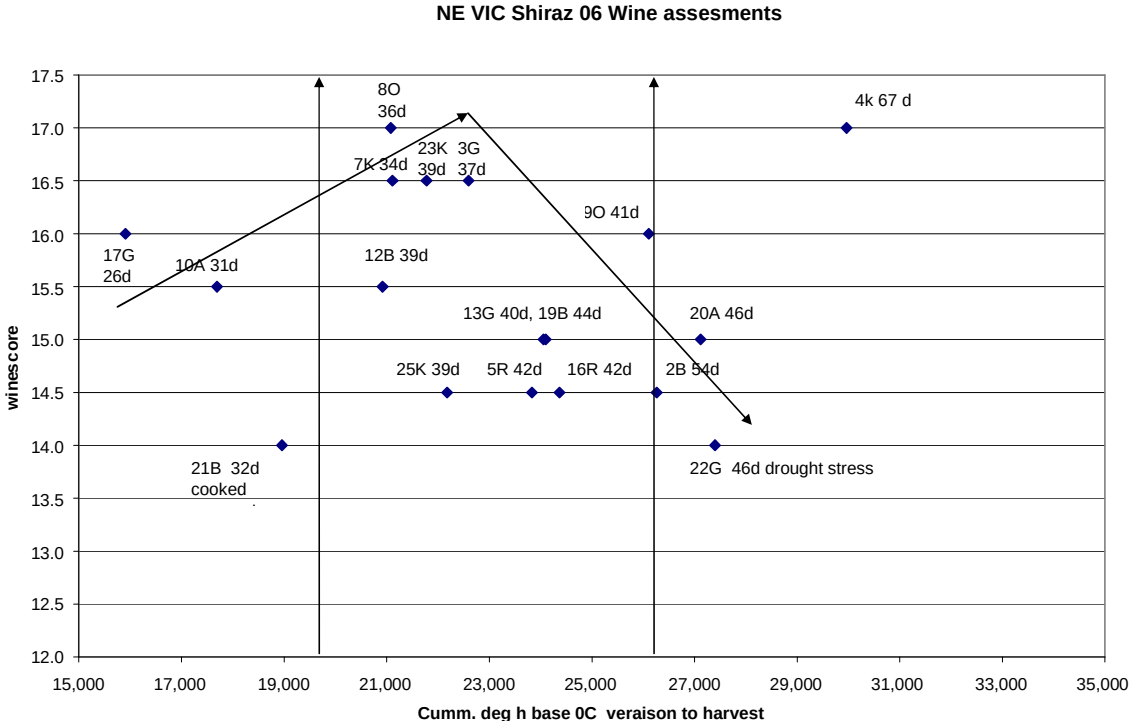
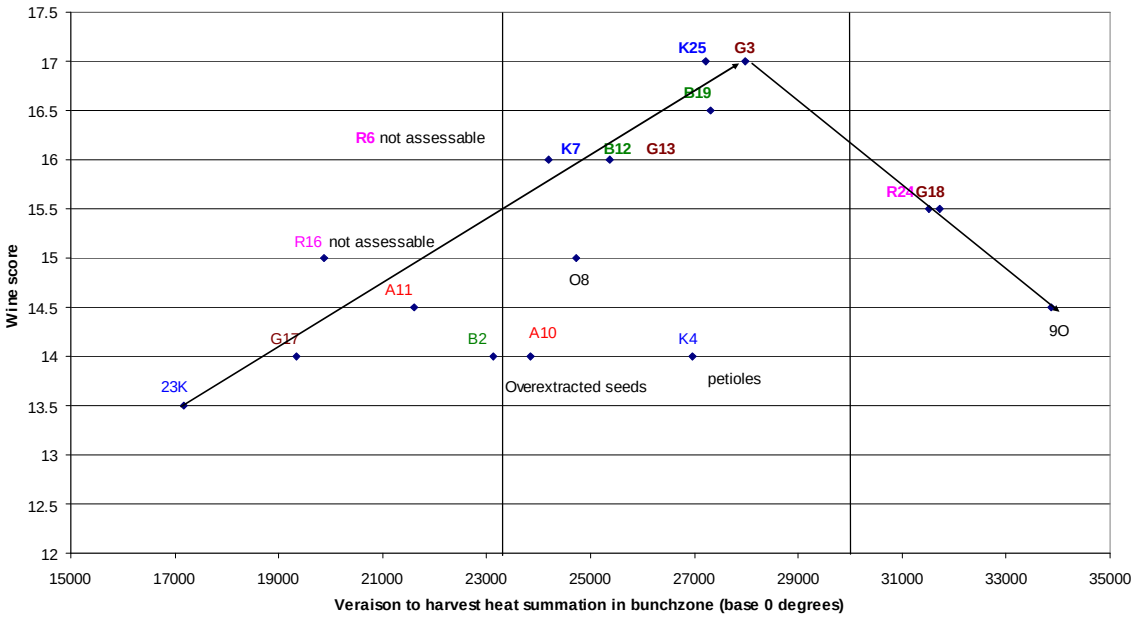


Fig. 240b: Last year the best wine scores were reached in a bracket of 23,000 – 30,000 cumulative degree hours in the bunchzones.



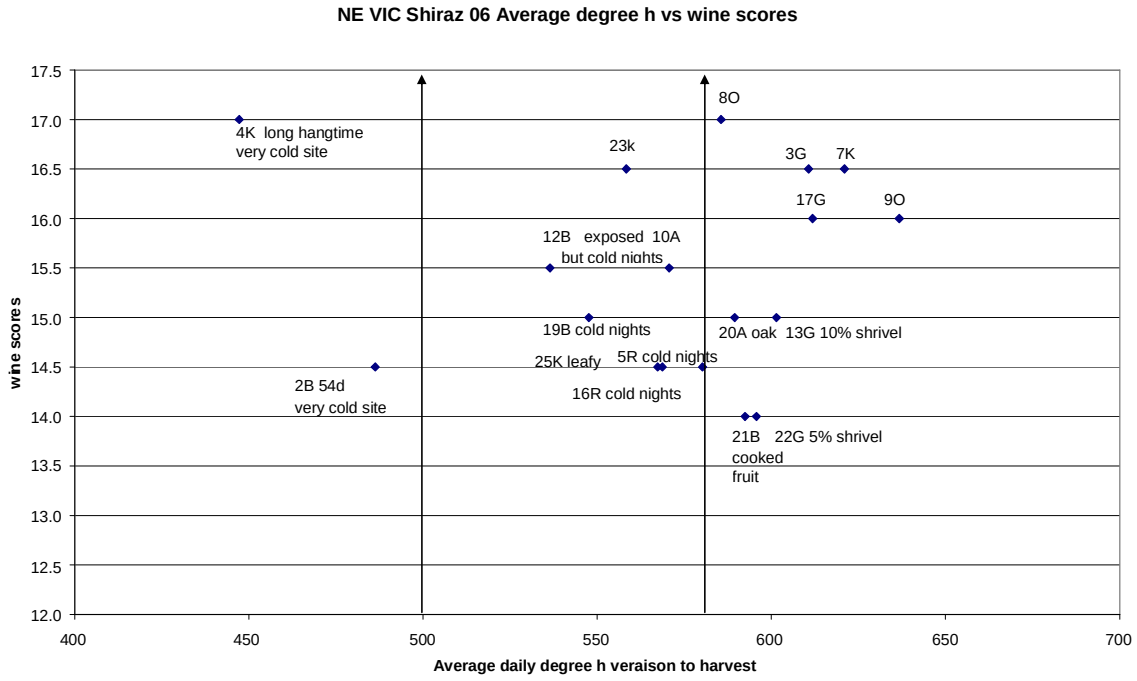
Average degree h gives a good indication of bunchzone temperature category brought about by site and canopy management.

Fig. 241: Three categories of bunchzones become evident in all of which better wine scores can be achieved due to better management.

Very cold sites in which very long hangtimes with appropriate canopy management (low leaf cover on east or south side) can result in good wine scores.

Cool sites or leafy vineyards (eg. 25K) pose a challenge and need longer hangtimes or else their wine descriptor diagrams look similarly flat (5, 16, 19) Longer hangtimes in warm dry years need better irrigation management. Those which have a vine balance of about 30 (high leaf area, eg 25) show fast sugar ripening which leads to physiologically unripe fruit at harvest. Bronze medal winning wines in this sector have more colour, tannins and fruit through better site adapted canopy management.

Warm sites contain the danger of drought stress or over-exposure related failures with wines of low scores having cooked aromas and rough tannins. Excellent scores can be obtained with short hangtimes and no extreme water shortage.



Discussion

Mesoclimate

- **This was a hotter, rain-poor year** and contrasted well to the two years before. A third year with a different macroclimate is needed to solidify the conclusions.

Vineyard management

- Irrigation practice but not output was recorded - **degree of plant drought stress this year would have been a useful measure** (*see Nicholas, 2004*)
- **Vines had more leaves on the shoots than last year** pushing vine balance up in value.
- In many vineyards leaves were healthier than the last two years due to good spring rains. Exception: Drought stressed vineyards.
- **This year more growers plucked leaves on the east and south sides of the rows** in response to last year's findings in a cooler year. Some vineyards did not have the intended number of leaves in front of bunches due to **drought stress related leaf loss**. This was particularly unbeneficial on the north or west side of rows.
- **Hangtime was winemaker dependent**. There was on average a shorter time from veraison to harvest than last year. However, some vineyards had double the hangtime than others.

Vine balance

- **Higher values this year** than recommended in the literature (*Smart and Robinson, 1991*) or during last year due to more leaves and lower bunch numbers/weights on the 20 shoots measured.
- **Vine balance depended significantly on average number/weight of bunches,** not significantly on area of leaves. Some bunch thinning had taken place and some poor set.
- **In a hot year like this with good leaf health and low fruit loading speeds up ripening.**
- Cane lignification was poor under stress (shrivelled berries) but in the rest of the vineyards not significantly related to vine balance.
- Like last year very **high vine balance enabled faster sugar loading**, in the medium range there was no trend.

Microclimate in bunchzones

- **Data loggers revealed again large differences in sum of degree hours in the bunchzones**. These were brought about by mesoclimate, canopy management and hangtime.
- Grapes in a canopy are about 10 degrees hotter at midday than the temperatures recorded in a Stevenson screen, often this year transgressing the beneficial sector at midday.
- The calculation of time in the physiological range (15-35C) is of interest but the degree hours above and below are of much greater relevance.
- The diurnal curves were most important to show the timing and duration of heatloads.
- Leaf cover measurements at the morning sun and afternoon sun side of the canopy were essential to determine reasons for diurnal curves.
- Photography could easily relate the curves to canopy structure.

Berry Baumé

- Sugar levels in grapes at harvest ranged from 12.8 to 16.8 Baumé.
- When bunchzone temperature summations were high (either due to heat or hangtime) sugar loading was low and vice versa. This was also significant in 05.
- The night temperatures had no influence on this relationship.
- Baumé at harvest and sugar loading speed was independent of fruit weight per shoot.

Berry TA

- Speed of acid depletion (TA/hangtime) was high in bunchzones with high summation of degree hours and low in cooler bunchzones. There is a scattered middle field. This was not significant in 05 (cooler) but showed the same trend.
- TA also was related to hangtime, shorter hangtimes often resulted in higher TA, as late season heatloads were avoided.
- When vineyards with very short hangtime were excluded, vineyards with higher vine balance values were retaining more acid.
- This depended on weight of fruit per shoot, not leafiness.
- **It can be concluded that acid retention may be favoured by bunch thinning and cool bunchzones.**

Berry Colour

- There is, in both years, only a slight trend that cooler bunches have higher colour
- Vine balance, hangtime, yield, Baumé at harvest and berry weight were not significantly related to colour at harvest
- There is a trend in this season for lower fruit weight per shoot being associated with better colour in bunches, in particular when shrivelled berries were excluded from statistics. In the cooler season 05 this was not seen.
- Bunches with many hours over 35C had lower colour.
- Low colour was associated with more than 2 leaf layers over the east or south (morning sun) sides of the bunchzones.
- When front and back leaves over bunches were averaged, the relationship became more distinct in the extremes and less clear in the middle field.
- Retaining leaves in the west and plucking in the east brought many vineyards closer to the optimum degree hour zone.
- Bunches with long either cold or hot hang times had lower colour
- Bunches with short hang times in the optimum middle range average degree hour zone (550-650) had best colour.
- Colour was higher in bunches with higher TA at harvest (2 exceptions in cold shaded bunchzones) or with better acid retention.
- **It may be concluded that in a hotter year colour may be best achieved when there is not too much bunch weight per shoot, no shrivel, good exposure to east or south, and in the optimum bunchzone temperature range with therein the shortest possible hangtime.**
- **Colour values in unshrivelled grapes (1.2 - 2.3 mg/g FW) are at the high end of the Shiraz spectrum** and compare favourably with those published for Coonawarra Shiraz (average 1.5-1.8 mg/g with a range from 0.9-2.6mg/g) (*Krstic et al, 2003*)

Berry Phenolics

- High total phenolics in ground up berry samples may be brought about by a mixture of skins and seeds in the extract. A combination of bitter unripe seeds and ripe skins that can be handled by winemaking practices can falsely produce a high phenolic concentration mainly from an unpleasant source. Therefore this year's results cannot be totally compared to last year's when skin phenolics alone were assessed after skin peeling and separating the seeds. (too costly).
- Comparison of endpoints (concentration at harvest) does not take into account the different picking decisions and is not an indicator of physiological capacity. It is better to study dynamics of quality traits.
- Ripe skins emit phenolics better thus riper skins and unripe seeds will lead to high amounts of phenolics per day.
- Fast sugar loaders are also fast phenolic ripeners and releasers – from what source will be seen by tasting the wine. The relationship was much stronger in 05 when only skins were extracted.
- Berries with fast acid loss (associated with high heat loads and or long hangtime) had a fewer phenolics per day of hangtime.

- Berries with 10 or 15% shrivel have very high phenolics in the extract (more extreme than colour) and upset statistical evaluations. In the hotter year 06 small berries had significantly higher phenolics than big berries.
- When anthocyanin and phenolic concentration at harvest are both divided by hangtime their relationship is almost linear, so they seem to underlie the same circumstances, but are more affected by berry weights in their final concentration.
- The relationship is higher than 1 in warmer vineyards where colour may be degraded in particular with longer hangtime, and below 1 in cooler vineyards, which can take advantage of longer hangtime and preserve colour better. This trend is much stronger in the cooler 05. In 04 most berries had higher phenolics than anthocyanins due to the very hot summer.
- **It may be concluded that water stress and berry size plays a very big role for the amount of phenolics released from berries. Seed size and number may be important but has not been assessed.**
- **In contrast to anthocyanins, for phenolics berry weight mattered. Small and shrivelled berries had high phenolics. In 05 small berries had a higher proportion of seeds.**
- **Very cold and very hot bunchzones produce lower total phenolics. The middle field is temperature unrelated in this warm year.**
- **The ratio between phenolics and anthocyanins when observed over 3 years, is higher in hotter bunches, locations and years and lower in cooler bunches, locations and years.**

Berry flavonols

- Flavonols were highest in grapes from west or north exposed bunchzones and lowest in grapes with high leaf cover on both sides.
- Concentrations of flavonols were highly related to phenolics, anthocyanins were not highly related to flavonols.

Berry chemistry with respect to bunchzone heatloads

- ***The most important finding of this benchmarking study was that as in last year's results, excellent colour was only produced in bunches with fast warm-up in the morning and no heatloads in the afternoon. Vineyards in cool locations benefited from plucking on the side exposed to the morning sun.***

Berry Sensory Assessment Results

- In general BSA scores were higher this year, many vineyards achieved a higher pulp maturity, pulp aroma and skin maturity
- Seed ripeness was not ideal and similar to last year
- **Pulp maturity** depended more on acid / sugar balance than Baumé
- Hotter not shrivelled berries had a lower pulp maturity
- **Pulp aroma** is best with longer hangtimes in beneficial conditions.
- Vineyards of which award winning wine scores were produced last year are this year in a temperature bracket of 20,000 – 25,000 degree hours (less due to shorter hangtimes) and have aroma ratings over 3.3 (2 exceptions)
- Highest pulp aroma ratings were from an average of 450-550 daily average degree hours
- Pulp aroma was independent of Baumé
- **Skin maturity** was independent of Baumé and reached at a wide range of degree hour summations, but was slightly lower at higher heatloads. This trend was also seen in 05.
- In 05 colour and skin maturity were related, in 06 not, due to shrivel, extreme hangtimes and many berries with good skin maturity.
- **Seed maturity** was far behind the other parameters, and unrelated to most parameters including weight of crop on shoot, Baumé, phenolics and other quality criteria. Last year high seed maturity was related to high % of seed weight of berry fresh weight and vice versa with a middle field in-between.

- **Total BSA scores** were better when bunches were not exposed to high average temperature summations
- **BSA scores without seed data significantly correlated with average bunchzone temperature summations – the less hot the better the score.** This was not visible last year as it was not hot enough.
- It may be concluded that in a hot year with no rain, pulp and skin ratings with more than 11 points could only be reached when daily average degree hours were below 600.
- **In particular high pulp aroma scores seem to depend on a beneficial bracket of average daily temperature summations of 450-550 degree hours**
- Last year many vineyards were in the beneficial range of average degree hours and still did not score above 11 points – rain in February may have contributed to slower maturity; water relations may be necessary to be monitored to give the bunch temperature/ berry maturity correlations a solid base.

Wine chemical analysis

- **There is some trend for higher anthocyanins in wine with higher anthocyanins in berries over 2 years but no relationship exists for total phenolics this year as seeds are extracted differently in ground up berries and in winemaking.**

Wine scores

- Total scores depended strongly on the sum of red fruit rating and less on colour and very little on tannin softness.

- In 2006, with higher amounts of cumulative degree h, the chances of achieving high red fruit scores are diminished. In 2005, best fruit aromas are reached at higher cumulative degree hours (due to colder nights) from where also a drop in fruit aroma occurs with higher heat loads.
- In 2006, with higher amounts of cumulative degree h and no drought stress the chances of having softer tannins in the wine may increase. In 2005, the cooler year, there is a linear relationship between cumulative degree h and tannin softness rating in wine.

- In 2006, wine scores above 15.5 were reached between 20,000 and 26,000 degree h in the absence of problems. Many wines have reached higher scores than the year before. Last year the best wine scores were reached in a bracket of 23,000 – 30,000 cumulative degree hours in the bunchzones.

- **Average degree h gives a good indication of bunchzone temperature category brought about by site and canopy management. Three categories of bunchzones become evident in all of which better wine scores can be achieved due to better management.**

  - **Very cold sites in which very long hangtimes with appropriate canopy management (low leaf cover on east or south side) can result in good wine scores.**
  - **Cool sites or leafy vineyards (eg. 25K) pose a challenge and need longer hangtimes or else their wine descriptor diagrams look similarly flat (5, 16, 19) Longer hangtimes in warm dry years need better irrigation management. Those which have a vine balance of about 30 (high leaf area, eg 25) show fast sugar ripening which leads to physiologically unripe fruit at harvest. Bronze medal winning wines in this sector have more colour, tannins and fruit through better site adapted canopy management.**
  - **Warm sites contain the danger of drought stress or over-exposure related failures with wines of low scores having cooked aromas and rough tannins. Excellent scores can be obtained with short hangtimes and no extreme water shortage.**

Recommendations

- ☞ A third year of bunchzone temperature data logging seems of interest to be able to publish the results, in particular those relating to canopy structure/leaf cover and morning/afternoon heat exposure and grape chemical and sensory analysis in a peer-reviewed journal.

- ☞ Soil and vine water relations must be recorded in case it is another rainless year, and irrigation must be measured and monitored (provided water availability)

- ☞ Vineyard variability with respect to Plant Cell Density of vines carrying data loggers and the rest of the vineyards should be evaluated from remote sensed imagery at veraison. Flight events can be shared by the vineyards of the regions and should be affordable. Ground truthing with GPS equipment will be needed (see *Proffitt, Bramley, Lamb and Winter, 2006*).

- ☞ Wines should be assessed when young and – if unblended – also when ready for sales.

References

Krstic, M., Moulds, G., Panagiotopoulos, B. and West, S. Growing quality grapes to winery specifications. *Winetitles 2003.*

Lowe, S. North East Victoria Wine Grape Quality Measurement and Benchmarking. Vintage 2004 *Report to GWRDC*.

Nicholas, P. Soil, Irrigation and nutrition. *Winetitles, 2004*

Proffitt, A., Bramley, R., Lamb, D. and Winter, E. Precision Viticulture. *Winetitles 2006*.

Rolley, L. Wine Grape Quality Measurement and Benchmarking. Central Victoria, Vintage 2002 and 2003. *Reports to GWRDC.*

Smart. R. and Robinson, M. Sunlight into wine. *Winetitles 1991*

Winter, E. Whiting, J. and Rousseau, J. Winegrape Berry Sensory Assessment in Australia. *Winetitles, 2004*.

Winter, E. and Whiting, J. Using leaf area to crop weight to determine vine balance. *Australian Viticulture Jan/Feb pp 70-73, 2004.*

Winter, E. Growing good Shiraz. Three years of Shiraz benchmarking studies in Victorian Vineyards. *Australian Viticulture Jan/Feb. pp 61-64, 2005.*

Winter, E., **Lowe, S.** Benchmarking NE Victorian Shiraz 04/05 Season. *Report to GWRDC.*

Winter, E., **Lowe, S. and Bulleid, N.** Effect of bunch temperatures on Shiraz flavour and aroma. *Poster at the 6th International Cool Climate Symposium Christchurch NZ, February 2006.*

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APPENDIX Table 1: Vineyard characteristics sorted by vineyard code.

NE VIC Shiraz 06 Vineyard information (N= new vineyard)

Vineyard Code	Area (Ha)	Slope %	Aspect facing which direction	Vine age	Trellis type	No. of wires	Row orientation	Row spacing in m	Vine spacing in m	Pruning Method	Clone	Root stock	Irrigation type	Water Source	Rain before verais.	Rain after verais.	Rain total mm	Yield (t/ha) insert post harvest
1A	3.2	20	ne	7	vsp	1	nw/se	3	2.0	spur	pt23	r99	drip	dam	245	70	315	10.0
2B	0.1	3	wnw	12	s/d	1	e/w	2.5	1.5	cane	na	schw	non	sky	225	71	316	6.0
3G	10.2	10	sw	10	s/d	1	nw/se	3	2.0	spur	na	na	drip	dam	210	72	317	5.9
4KN	3.0	3	e	4	vsp	1	ne/sw	3	1.8	spur	1654	paul	drip	creek	255	73	318	11.3
5R	6.0	10	sw	9	sprawl	1	ne/sw	3	2.1	spur	1654	r99	drip	dam	243	74	319	8.7
6R	12.0	10	wnw	8	s/d	1	nw/se	3	2.0	spur	1654	schw	drip	dam	230	75	320	11.0
7K	2.1	5	wsw	12	s/h	2	n/s	3	1.8	spur	na	schw	drip	dam	205	76	321	7.2
8O	4.0	0	0	14	s/d	1	n/s	3	3.0	spur	pt23	schw	furr	river	215	77	322	9.9
9O	6.0	15	wnw	8	s/d	1	n/s	3	2.0	spur	tahbilk	rug/paul	drip	dam	270	78	323	2.8
10A	3.0	10	nw	11	s/d	1	ne/sw	3	2.0	spur	pt23	schw	non	sky	339	79	324	5.0
11A	2.4	25	e	8	s/d	1	n/s	3	2.0	spur	1654	teleki	drip	dam	237	80	325	9.3
12B	1.0	3	n	8	s/d	1	n/s	3	2.4	spur	pt23	schw	drip	dam	268	81	326	4.0
13G	2.1	3	wsw	12	vsp	1	nw/se	3.3	2.7	spur	pt23	schw	non	sky	222	82	327	6.0
14K	4.4	0	0	12	s/d	1	n/s	3	3.0	spur	pt23	schw	drip	dam	255	83	328	7.5
15R	4.5	3	w	10	s/h	2	e/w	3	2.0	spur	pt23	kober	drip	river	220	84	329	12.5
16R	2.2	3	n	9	s/h	2	ne/sw	3	2.0	spur	pt23	kober	drip	dam	265	85	330	10.0
17G	2.0	5	sw	8	vsp	1	nw/se	3	1.8	cane	pt23	rugg	drip	dam	208	86	331	4.4
18G	2.3	3	e	8	s/d	1	n/s	3	2.0	spur	pt23	schw	drip	dam	207	87	332	3.7
19B	3.4	10	n	7	s/d	1	n/s	3	2.0	spur	pt23	schw	drip	dam	257	88	333	6.3
20A	4.0	0	0	11	s/d	1	ne/sw	3	3.0	spur	pt23	schw	drip	river	251	89	334	13.0
21B	5.0	25	w	8	s/d	1	e/w	2.7	1.8	spur	bvrc12	r99	drip	dam	265	90	335	3.7
22G	2.0	1	nw	36	sprawl	1	ne/sw	3.3	1.8	spur	na	arg1	drip	dam	225	91	336	5.0
23K	5.0	10	n	8	s/d	1	e/w	3	3.0	spur	pt23	schw	drip	dam	267	92	337	5.0
24R	2.0	0	0	6	s/h	1	n/s	3	2.0	spur	bvrc12	schw	drip	river	261	93	338	10.0
25K	1.5	15	w	10	s/d	1	n/s	2.7	2.5	spur	1654	schw	drip	river	275	94	339	2.0
26G	3.0	10.0	sw	10	s/d	1	nw/se	3	2.0	box he.	na	na	drip	dam	210	95	340	10.3
Av.	3.7	7.8		10.2											243.5	82.5	327.5	7.3

Tab. 2: Veraison and pre- harvest vineyard assessments

Shiraz Vineyards NE VIC 05/06 Averages from 20 shoots in 3 panels

						50% VERAISON									Pre- HARVEST						
Vineyard Code	Trimmed	no. of leaves/ shoot sized 100 cm^2	no. of leaves/ shoot sized 150 cm^2	no. of leaves/ shoot sized 200 cm^2	**Active leaf area cm2**	No act. Leaves	leaf no. per shoot	**young/ active leaves**	av. bunch number per shoot	No. of actively growing tips per shoot	% of canes lignified	leaf layers over bunches front	no of leaf layers over bunches back	leaf condition mature leaves	condit. four oldest leaves	condit. younger leaves	leaf layers over bu. front	front =	leaf layers over bu. back	Av Bunch weight (gm)	**Vine balance**
1A	1	20.2	2.5	5.7	3535	28	37	0.77	1.6	0.1	4.0	1.9	1.9	4.9	2.9	4.0	1.5	e	2.1	180	12.3
2B	1	15.7	3.1	4.4	2915	23	31	0.75	1.4	0.0	2.6	1.3	2.3	4.7	3.0	4.0	0.8	s	1.4	120	17.4
3G	1	31.9	5.7	5.3	5105	43	59	0.73	1.0	0.3	3.4	3.2	2.2	5.0	2.7	3.7	0.8	e	3.1	150	34.0
4KN	1	16.8	2.9	3.5	2815	23	30	0.77	1.4	0.1	4.3	1.9	2.5	4.9	3.2	3.7	0.9	w	1.8	150	13.4
5R	1	30	2.7	5.1	4425	38	50	0.75	1.1	0.4	2.7	2.2	2.1	5.0	3.1	4.0	2.1	n	2.2	150	26.8
6R	1	20.1	4.8	5.7	3870	31	45	0.68	1.5	0.6	3.5	2.8	3.1	4.9	3.2	4.0	2.7	s	3.5	200	12.9
7K	1	16.9	2.5	4.6	2985	24	30	0.80	1.0	0.0	3.2	1.7	2.2	3.9	2.9	3.7	1.6	w	1.2	170	17.6
8O	1	15.7	2.0	5.2	2910	23	29	0.80	1.4	0.1	4.1	2.0	1.9	4.7	3.0	4.0	1.6	e	1.9	95	21.9
9O	1	24.8	2.6	2.9	3450	31	40	0.76	0.8	0.0	3.3	1.5	1.0	3.4	2.3	3.9	1.7	w	0.7	100	43.1
10A	1	12.5	4.1	5.5	2965	22	32	0.68	1.5	0.1	4.2	0.6	3.0	4.9	3.1	4.0	0.6	e	3.1	200	9.9
11A	1	30.2	3.3	5.0	4515	38	50	0.77	1.4	0.1	3.3	1.4	2.6	4.0	3.3	4.0	1.5	e	2.5	150	21.5
12B	1	15.7	2.5	6.5	3245	25	36	0.70	1.0	0.1	4.2	1.5	1.9	4.6	3.2	4.0	0.9	e	1.4	180	18.0
13G	1	17.3	2.7	3.2	2775	23	34	0.68	1.6	0.0	2.9	1.7	2.3	4.2	2.4	3.8	1.2	w	1	85	20.4
14K	1	25.2	5.0	7.2	4710	37	50	0.75	1.7	0.8	1.7	1.5	4.6	4.9	3.7	4.0	0.8	e	3.2	180	15.4
15R	1	11.2	3.2	4.2	2440	19	31	0.61	1.3	0.1	3.8	3.0	3.6	5.0	3.1	4.0	1.6	n	2.8	160	11.7
16R	1	22.2	2.7	6.5	3925	31	41	0.77	1.1	0.0	2.5	1.0	2.2	3.3	2.1	3.7	0.9	n	1.7	110	32.4
17G	0	16.3	2.1	4.0	2745	22	31	0.73	1.5	0.0	4.0	1.2	1.5	5.0	2.9	3.6	1.2	e	1.7	90	20.3
18G	1	15	3.1	5.5	3065	24	36	0.65	1.5	0.2	3.8	2.7	1.9	4.8	2.4	3.8	1.8	w	1.2	160	12.8
19B	1	27.1	3.4	7.3	4680	38	50	0.75	1.2	0.8	3.7	2.8	1.7	5.0	2.3	3.6	1.4	w	0.8	220	17.7
20A	1	32.7	4.3	6.3	5175	43	55	0.79	1.4	0.9	2.6	1.5	2.1	4.7	3.1	4.0	1.5	w	1.8	260	14.2
21B	1	29.1	1.7	6.6	4485	37	49	0.76	1.3	0.0	4.1	1.7	1.9	4.0	2.7	3.8	1.3	n	1.5	130	26.5
22G	1	14.9	4.0	2.0	2490	21	32	0.65	1.7	0.0	3.6	2.9	2.9	5.0	3.5	4.0	2.6	n	2.9	130	11.3
23K	1	24	3.7	7.5	4455	35	47	0.74	1.2	0.3	3.5	2.1	1.1	4.6	3.5	4.0	2.2	n	1.5	140	26.5
24R	0	28.9	4.9	5.2	4665	39	60	0.65	1.7	0.6	2.1	2.3	2.7	5.0	3.6	4.0	2.2	e	2.2	105	26.1
25K	1	29.1	3.3	9.0	5205	41	54	0.77	0.8	0.6	3.4	2.5	1.8	5.0	3.0	3.9	2.1	w	1.2	180	36.1
26G	1	25.7	3.5	6.2	4335	35	51	0.69	1.4	0.3	3.4	3.3	2.2	4.9	3.5	4.0	2.7	w	1.2	185	16.7
Av.	0.9	21.9	3.3	5.4	3765	31	42	0.73	1.3	0.3	3.4	2.0	2.3	4.6	3.0	3.9	1.5		1.9	153	20.7
	1=y 0=no	use template diam. 11.3cm	use template diam. 13.8cm	use template diam. 16cm	calculation			calcuation	after bunch removal if done	average for the vine	1=<20% 2=21-40% 3=41-60% 4=61-80% 5=81-100	.		5=green 4=pale green 3 =yellowing 2=yell/brown 1 = absent				direction		from fruit assessment	leaf area/g fruit wt
Av.	last y.	17.3	5.2	5.0	3795	28	41	0.7	1.8	0.4	3.4	2.5	3.4	3.7	2.5	3.5	1.9		2.2	158	13.0

Tab 3: Comparative bunchzone temperatures 05 and 06 veraison to harvest

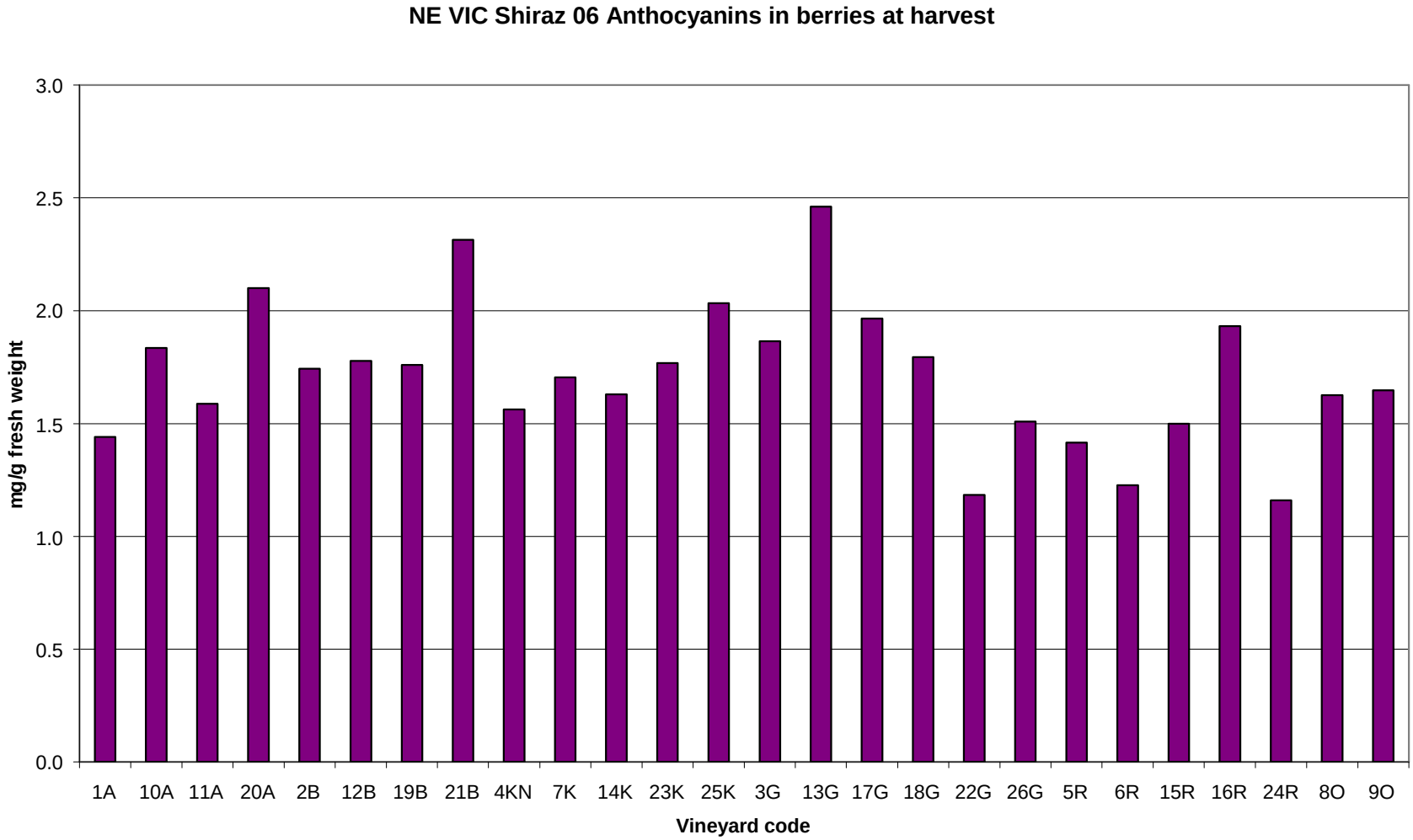
Vineyard Code	06 No. of days ver-harv.	05 No. of days ver. to harv.	06 Ver-Ha degree hours above 0°C	05 Ver-Ha degree hours above 0°C	06 Average degree hours above 0	05 Average degree hours above 0	Ver-Ha degree hours above 35 °C	05 Ver-Ha degree hours above 35 °C	Ver-Ha degree hours below 15°C	05 Ver-Ha degree hours below 15°C	Ver-Ha degree hours between 15 and 35 °C	05 Ver-Ha degree hours between 15 and 35 °C	Average degree hours between 15 and 35 °C	Average degree hours between 15 and 35 °C
1A	40	35	24,058	17,379	601	497	486	26	306	612	23,266	16,741	582	478
2B	54	52	26,260	23,140	486	445	226	66	1,843	2,164	24,191	20,910	448	402
3G	37	57	22,596	27,992	611	491	466	202	498	1,660	21,632	26,130	585	458
4KN	67	na	29,964		447		151		3,056		26,757		399	
5R	42	61	23,831	28,469	567	467	677	614	880	3,127	22,274	24,728	530	405
6R	na	41		19,307		471		89		1,039		18,179		443
7K	34	47	21,114	23,240	621	494	379	203	323	1,243	20,412	21,794	600	464
8O	36	52	21,080	24,723	586	475	410	74	286	1,368	20,384	23,281	566	448
9O	41	67	26,107	33,878	637	506	944	475	245	1,740	24,918	31,663	608	473
10A	31	57	17,692	23,840	571	418	710	213	889	3,582	16,093	20,045	519	352
11A	40	43	24,209	21,619	605	503	547	175	428	1,225	23,234	20,219	581	470
12B	39	52	20,921	24,206	536	466	399	424	1,002	2,104	19,520	21,678	501	417
13G	40	51	24,059	25,365	601	497	183	136	272	1,148	23,604	24,081	590	472
14K	60	61	26,869	26,512	448	435	0	2	1,823	1,855	25,046	24,655	417	404
15R	39	45	24,989	22,505	641	500	805	144	249	886	23,935	21,475	614	477
16R	42	43	24,370	19,871	580	462	820	35	861	1,391	22,689	18,445	540	429
17G	26	38	15,908	19,348	612	509	182	78	128	746	15,598	18,524	600	487
18G	47	63	29,941	31,724	637	504	1,385	138	184	1,156	28,372	30,430	604	483
19B	44	54	24,096	24,691	548	457	160	26	932	2,019	23,004	22,646	523	419
20A	46	na	27,116		589		503		534		26,079		567	
21B	32	43	18,958	19,957	592	464	408	18	347	1,268	18,203	18,671	569	434
22G	46	64	27,402	30,387	596	475	940	207	561	2,276	25,901	27,904	563	436
23K	39	36	21,777	17,172	558	477	242	125	647	1,116	20,888	15,931	536	443
24R	54	66	34,203	31,514	633	477	914	153	498	2,084	32,791	29,277	607	444
25K	39	59	22,180	27,227	569	461	315	6	364	1,675	21,501	25,546	551	433
26G	40	na	24,170		604		430		530		23,210		580	
Average	42	52	24,155	24,525	579	476	507	158	707	1,630	22,940	22,737	551	442

Tab. 4: Chemical analysis of berries and young wine

NE VIC Shiraz 06 Berries and Wine

									Berries			Wine				
Vineyard Code	No 06 No. of	Av. degree hours above 0	Vine Vine balanc	Berry TA	Berry pH	% Shrivel	Berry Be	Av. Berry weight (gms)	mg/g FW Anthocyanins	AU/g FW Flavonols	AU/g FW Phenolics	pH	AU Red pigments	Flavonols	Phenolics	mg/L Anthocyanins
1A	40	601	12.3	3.9	4.1	0	14.1	1.2	1.4	0.9	4.6	3.7	33.5	15.3	57.1	670.6
2B	54	486	17.4	6.4	3.8	0	12.2	0.7	1.7	1.3	7.5	3.7	39.9	11.5	48.6	797.9
3G	37	611	34.0	5.4	4.0	0	13.3	1.2	1.9	1.1	5.3	3.5	45.7	18.1	81.5	913.0
4KN	67	447	13.4	4.1	4.1	0	14.3	1.1	1.6	0.8	4.4	3.5	30.9	12.8	60.9	618.1
5R	42	567	26.8	4.7	4.1	5	14.4	1.2	1.4	1.3	6.4	3.7	26.9	10.8	47.3	537.3
6R	na		12.9	4.3	4.0	0	14.0	1.1	1.2	0.8	4.1	3.6	39.7	16.1	62.5	793.9
7K	34	621	17.6	5.2	3.9	0	14.6	1.1	1.7	1.2	5.7	3.6	40.9	21.9	84.2	818.1
8O	36	586	21.9	4.9	4.0	5	15.3	1.0	1.6	1.3	6.6	3.8	32.0	13.5	50.1	640.3
9O	41	637	43.1	5.3	4.1	0	14.7	0.8	1.6	1.8	8.3	3.6	41.4	22.1	77.8	828.2
10A	31	571	9.9	5.9	3.9	0	15.3	1.2	1.8	1.3	6.3	3.8	46.2	21.3	71.5	923.1
11A	40	605	21.5	4.2	4.1	0	14.0	1.1	1.6	1.1	5.2	3.7	46.5	18.9	68.4	929.2
12B	39	536	18.0	4.8	3.9	0	15.1	1.1	1.8	1.1	5.0	3.5	34.0	15.5	54.4	680.7
13G	40	601	20.4	5.0	3.8	10	12.8	0.6	2.5	2.4	12.5	4.0	46.5	19.7	78.2	929.2
14K	60	448	15.4	6.8	3.8	0	14.3	1.5	1.6	0.5	3.1	3.8	36.2	10.0	49.6	723.2
15R	39	641	11.7	4.3	4.1	5	15.2	1.2	1.5	0.9	4.4	3.9	39.0	15.6	66.3	779.7
16R	42	580	32.4	5.3	4.0	15	13.7	0.7	1.9	2.0	11.1	3.3	26.5	15.0	65.1	529.2
17G	26	612	20.3	4.7	3.9	0	15.1	1.2	2.0	0.9	5.0	4.0	48.6	26.2	82.5	971.6
18G	47	637	12.8	5.0	3.9	0	15.3	1.1	1.8	1.2	6.5	3.7	37.9	17.1	73.6	757.5
19B	44	548	17.7	4.2	4.2	0	15.6	1.0	1.8	1.1	5.5	3.8	51.3	21.8	78.7	1026.2
20A	46	589	14.2	5.0	4.1	0	14.7	1.1	2.1	1.5	7.1	3.7	42.7	14.4	64.1	854.5
21B	32	592	26.5	3.8	4.2	0	13.8	0.9	2.3	1.6	8.1	3.8	47.8	17.7	75.6	955.5
22G	46	596	11.3	4.6	3.9	5	13.8	1.1	1.2	1.0	5.1	3.4	37.9	15.5	73.0	757.5
23K	39	558	26.5	5.7	4.0	0	14.0	1.1	1.8	1.1	5.4	3.8	50.9	19.3	74.4	1018.1
24R	54	633	26.1	3.2	4.3	0	14.0	1.1	1.2	1.1	4.2					
25K	39	569	36.1	5.9	3.9	0	16.8	1.0	2.0	1.4	7.5	3.8	44.6	16.8	71.8	892.8
26G	40	604	16.7	5.0	4.0	0	12.8	1.2	1.5	0.9	4.6	3.4	33.5	12.4	59.5	670.6
Av.	42.2	579.1	20.7	4.9	4.0	1.7	14.4	1.1	1.7	1.2	6.1	3.7	40.0	16.8	67.1	800.6

Tab. 4b: Synopsis of anthocyanin concentrations by vineyards grouped for the regions



Tab. 5: Berry Sensory Assessment

BSA results NE VIC Shiraz 05/06 Assessor S.Lowe **Average over 6 BSA readings**

Vineyard Code	Vine balance	No. of days flow.-harv.	No. of days ver-harv.	Ver-Ha deg. h above 0°C	Av. degree h above 0	Be	TA	pH	weight (gms)	% Shrivel	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
1A	12.3		40	24,058	601	14.1	3.9	4.1	1.2	0	3.8	3.2	3.8	3.2
2B	17.4		54	26,260	486	12.2	6.4	3.8	0.7	0	4.0	3.7	4.0	3.3
3G	34.0		37	22,596	611	13.3	5.4	4.0	1.2	0	3.8	3.5	4.0	3.0
4KN	13.4		67	29,964	447	14.3	4.1	4.1	1.1	0	4.0	3.5	4.0	3.2
5R	26.8		42	23,831	567	14.4	4.7	4.1	1.2	5	3.5	3.0	3.3	3.0
6R	12.9		na			14.0	4.3	4.0	1.1	0	3.8	3.0	3.8	2.8
7K	17.6		34	21,114	621	14.6	5.2	3.9	1.1	0	3.3	3.0	3.5	2.6
8O	21.9		36	21,080	586	15.3	4.9	4.0	1.0	5	4.0	3.3	4.0	3.3
9O	43.1		41	26,107	637	14.7	5.3	4.1	0.8	0	4.0	3.5	4.0	3.2
10A	9.9		31	17,692	571	15.3	5.9	3.9	1.2	0	4.0	3.3	4.0	3.0
11A	21.5		40	24,209	605	14.0	4.2	4.1	1.1	0	3.8	3.2	3.6	3.0
12B	18.0		39	20,921	536	15.1	4.8	3.9	1.1	0	4.0	3.5	4.0	3.2
13G	20.4		40	24,059	601	12.8	5.0	3.8	0.6	10	4.0	3.3	4.0	3.0
14K	15.4		60	26,869	448	14.3	6.8	3.8	1.5	0	3.7	3.2	3.7	3.0
15R	11.7		39	24,989	641	15.2	4.3	4.1	1.2	5	3.3	3.2	3.5	3.0
16R	32.4		42	24,370	580	13.7	5.3	4.0	0.7	15	3.7	3.0	3.3	3.0
17G	20.3		26	15,908	612	15.1	4.7	3.9	1.2	0	3.8	3.2	4.0	3.2
18G	12.8		47	29,941	637	15.3	5.0	3.9	1.1	0	3.7	3.2	3.5	3.0
19B	17.7		44	24,096	548	15.6	4.2	4.2	1.0	0	4.0	3.7	4.0	3.3
20A	14.2		46	27,116	589	14.7	5.0	4.1	1.1	0	3.8	3.2	3.7	3.0
21B	26.5		32	18,958	592	13.8	3.8	4.2	0.9	0	3.5	3.3	3.8	3.0
22G	11.3		46	27,402	596	13.8	4.6	3.9	1.1	5	3.8	3.5	3.8	3.0
23K	26.5		39	21,777	558	14.0	5.7	4.0	1.1	0	3.8	3.2	4.0	3.0
24R	26.1		54	34,203	633	14.0	3.2	4.3	1.1	0	3.8	3.2	3.8	3.2
25K	36.1		39	22,180	569	16.8	5.9	3.9	1.0	0	4.0	3.5	4.0	3.2
26G	16.7		40	24,170	604	12.8	5.0	4.0	1.2	0	3.5	3.2	3.7	3.2
Average 06			42	24,155	579	14.4	4.9	4.0	1.1		3.8	3.3	3.8	3.1
Average 05				24,525							3.4	3.1	3.6	3.0

Tab. 6: Wine making parameters

Winemaking Parameters

Vineyard	Grape	Harvest	Grape	% runoff	% runoff	Additions			Cold soak		Type of	Stir cap	Juice	Cap	Days	Press.	Yield
Code	Be	method	temp °C	pre crush	post crush	Tannins g/t	Red tannin or Grape extract	Oak kg/t	days	Temp °C	Fermenter	times /day	Temp max	Temp max	on skins	Be	L/t
1A	14.1	machine	20	0	0	35	0	0.7	1	10	static	4	25	29	6	0.8	770
2B	12.2	hand	22	0	0	0	0	0.0	0	0	open	4	22	22	4	1.6	650
3G	13.3	machine	n/a	0	10	75	0	0.0	0	0	open	3	28	n/a	10	0.6	650
4KN	14.3	machine	n/a	0	0	34	0	3.8	0	0	sweep	4	26	28	8	0.8	760
5R	14.4	machine	20	0	0	180	0	0.0	0	0	static	4	28	31	8	0.5	744
6R	14.0	machine	15	0	0	100	0	0.0	0	0	static	3	27	27	6	0.5	780
7K	14.6	machine	20	0	5	200	0	0.0	0	0	open	3	28	34	7	-1.0	707
8O	15.3	machine	20	0	0	35	0	0.7	1	10	rotary	4	25	29	6	0.8	770
9O	14.7	machine	18	0	10	100	0	0.0	2	18	open	4	28	28	10	-0.6	565
10A	15.3	hand	27	0	10	0	0	0.0	4	20	open	5	29	n/a	12	0.0	535
11A	14.0	machine	15	0	0	35	0	0.0	0	0	static	4	25	29	5	1.8	770
12B	15.1	hand	18	0	0	0	0	0.0	10	12	open	4	30	32	7	0.0	700
13G	12.8	machine	20	0	0	0	0	0.0	0	0	static	2	27	30	10	0.0	720
14K	14.3	machine	n/a	0	0	75	0	0.0	1	16	static	4	27	28	7	1.0	792
15R	15.2	machine	20	0	0	35	0	0.0	0	0	static	2	32	n/a	6	-0.2	787
16R	13.7	machine															
17G	15.1	hand															
18G	15.3	machine	n/a	0	0	75	0	0.0	0	0	static	4	27	27	12	0.0	667
19B	15.6	machine	n/a	0	0	0	50g/t	0.0	3	10	static	4	27	27	8	0.0	800
20A	14.7	hand	24	0	10	100	0	3.6	0	0	open	3	33	n/a	6	0.0	616
21B	13.8	hand	18	0	0	0	0	0.0	0	0	open	4	30	20	14	0.5	750
22G	13.8	machine	n/a	0	0	75	0	0.0	0	0	static	3	28	n/a	9	0.8	780
23K	14.0	machine	n/a	0	0	40	0	2.0	0	0	open	4	30	30	8	0.0	690
24R	14.0	machine	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
25K	16.8	machine	19	0	0	112	0	2.0	0	0	open	2	32	32	8	-0.1	700
26G	12.8	machine	n/a	0	0	75	0	0.0	0	0	static	3	28	n/a	6	0.2	780

Tab. 7 Wine judgement

NE VIC Shiraz 06 Young unfinished wine assessments

	Aroma (0=absent, 5= intense)										Mouthfeel (0=absent, 5 = intnese)					
Vineyard Code	Herbaceous	Bitter	Green/ White Pepper	Black Pepper	Raspberry	Plum	Blackberry	Mulberry	Licorice	Black olive	Jam	Tannin softness	Tannin intensity	Hue	Colour	"Wine Show" Score	Taster's note
1A																	
2B	3	2	3	1	3	2	1	0	0	0	0	3	1	3	2	14.5	oaky
3G	0	0	0	1	3	3	4	2	2	0	1	3	3	5	4	16.5	
4KN	0	0	0	1	3	1	2	1	0	0	0	4	3	3	3	17.0	
5R	0	0	0	1	1	3	2	2	1	0	0	2	2	2	3	14.5	aldehyde
6R	2	1	2	1	3	1	1	0	0	0	0	2	3	3	3	14.0	
7K	0	0	0	0	1	3	4	3	2	0	2	2	4	4	5	16.5	mouse
8O	0	0	0	1	2	4	4	3	2	3	2	3	3	5	4	17.0	
9O	0	0	0	0	2	3	3	2	0	0	0	4	4	2	3	16.0	
10A	0	0	0	1	2	2	3	1	0	0	0	3	4	3	4	15.5	aldehyde
11A																	
12B	0	0	0	2	3	1	2	0	0	0	0	2	4	4	3	15.5	va
13G	0	0	0	0	2	4	2	2	2	0	3	5	4	3	4	15.0	aldehyde
14K																	
15R																	
16R	0	0	0	0	1	3	2	1	0	0	2	3	3	3	4	14.5	aldehyde
17G	0	0	0	1	1	4	3	2	2	1	2	3	5	4	5	16.0	
18G																	
19B	3	1	3	3	2	3	2	2	0	0	0	3	4	3	4	15.0	
20A	1	0	0	1	3	1	1	1	0	0	0	2	3	4	2	15.0	
21B	0	0	0	0	0	4	2	2	3	3	3	3	3	4	5	14.0	
22G	1	0	1	0	3	2	1	1	0	0	0	2	2	4	3	14.0	oaky
23K	1	1	1	3	2	4	3	2	2	1	2	3	3	3	4	16.5	leesy
24R																	
25K	1	0	1	0	3	2	2	1	0	0	0	2	2	2	3	14.5	chewy
26G																	