Benchmarking Mornington Peninsula Pinot noir vineyards Season 06/07





TECHNICAL REPORT

To the GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION
MORNINGTON PENINSULA VIGNERONS ASSOCIAION

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Abstract

The aim of the project was to provide grapegrowers and winemakers with detailed information for a second year about many aspects of their vineyards.
Detailed vineyard descriptions and vine measurements were made of active leaf area per shoot, young to active leaves, number of shoot tips, degree of cane lignification, leaf cover over bunches differentiated by side of canopy, leaf health, fruit load per shoot and resulting vine balance values at veraison, and leaf cover and health pre harvest. Bunchzone temperatures were recorded from veraison to harvest by data loggers and temperature summations as well as daily diurnal curves were generated. Grape samples were collected for berry sensory assessment and standard chemical analysis. Five month old wines were assessed by a panel of five judges and chemically analysed.
Individual vineyard data and photos were compiled, compared to each other and those of last year and distributed to the participants as a report.
Communication between participants was enhanced in group meetings and a forum in which all wines were blind tasted by all participants.
The good cross section of vineyards, grapes and wines showed similarities from which regional styles can be described. The large amount of individual data can be used to better understand and modify vineyard and winemaking practices to improve grape and wine quality.

Background

RITA benchmarking projects have in the past aimed at increasing the adoption of better management practices and at better understanding site –management interactions. An overview about the results of early RITA Shiraz benchmarking projects in Victoria between 2000 and 2004 was provided in Australian Viticulture (*Winter, 2004*).

A 2 year Shiraz benchmarking project with new methodology was carried out with 26 vineyards over 5 regions between 2004 and 2006 in NE VIC and reported in Australian Viticulture *(Winter, Lowe and Bulleid, 2007*). Amongst other aims, the hypothesis based on work of *(Haselgrove et al., 2000, Tarara et al. 2000, Spayd et al. 2002*) who demonstrated the negative effect of heatloads on fruit quality was tested and confirmed. Canopy management practices were changed by 35% of growers in the second year to allow the morning sun to reach the bunches and to protect them from the afternoon sun, which improved grape and wine outcomes, provided there was no water shortage in the vineyards and no winemaking problem.

A similar benchmarking study to the above, but in Pinot noir, has been carried out in the Yarra Valley and the Mornington Peninsula in 05/06 (*Winter, Braybrook and Aldridge*, Report to GWRDC 2006). The hypothesis tested in the inland vineyards of NE VIC was confirmed in the Yarra Valley, but the Mornington Peninsula results differed, probably due to the more maritime location.

As the Mornington Peninsula was not affected by frost and other problems and 16 previous vineyards were keen to continue, partial funding was granted from GWRDC to conduct the smaller study for 06/07. This new study was only possible as the Mornington Peninsula Vignerons financially contributed to achieve the same detailed data assembly and reporting as in the previous year.

Material and Methods:

Vineyard selection and coding
Sixteen vineyards from the MP 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; the vineyards had the same numbers as in 06. All further data generation and processing was strictly anonymous by code only.

Vineyard locations
The vineyards are located approximately 1h south of the city of Melbourne. Vineyards have been managed in these areas for many years. Site management practices appear to be well established.

The **Mornington Peninsula** is unique compared to other Pinot growing areas as it is surrounded on 3 sides by ocean. Gladstones wrote: "with its peninsular geography reduces temperature variability, including that of the maximum…the potential drawbacks are lack of continentality and strong winds" *(Gladstones, 1994).*

Climatic information
Climatic data both, long term average and recent, consisting of temperature and rainfall was obtained from the Bureau of Meteorology.

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

Vineyard scoring
The sampling technique involved randomly selecting rows and "zig–zagging" along each side. Scoresheets incorporated veraison measurements and pre harvest assessments (**Tab. 2**). During the veraison assessment 20 shoots were 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 of shoots, 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 the average bunch weight was recorded. From the active leaf area per shoot and the bunch number and weight vine balance could be calculated *(Winter and Whiting, 2004)*.

Bunch climates Data loggers (*Tinytag*, Hastings, Port Macquarie) purchased by the growers were attached to the trellis posts within the vine canopy at the height of the bunch zone The logger was positioned to face along the vine row in the orientation of the warmest direction. Measurements were taken hourly from veraison to harvest, but in some cases somewhat shorter due to malfunction of the loggers **Tab. 3**. Data were downloaded with the appropriate software 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. In order to be able to compare the vineyards despite different logging time average daily temperature summations were calculated dividing the total summation by days of logging. It is also possible to set points in the loggers above and below which degree hours can be calculated. In comparison to other work in Victoria the lower cut-off point was 15C, but for Pinot the upper cut-off point was only at 26C *(Pirie and Mullins, 1980*). In-between those points average degree hours in the optimum range was calculated.

Phenology
Veraison (expressed as % berries with colour change) and harvest dates were recorded in the vineyard scoresheets and phenology was calculated from 50% veraison (**Tab. 4**).

Berry sensory assessment
Berry Sensory Assessment was carried out pre harvest (**Tab. 4**) by AWC (to ensure comparability) according to *Winter et al. 2004*. The 6 bunch samples were collected by the field assessor at the same time as the grape sample for chemical analysis and delivered directly to AWC for assessment.

Grape sampling for chemical analysis
Pre harvest fruit 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.

Grape chemical analysis
Three grape samples per vineyard (in separate labelled plastic bags) were delivered by the field assessor to *Vintessetntials, Dromana, VIC*. The samples consisted of 25 small bunchlets (of 10 or 12 berries each) collected randomly 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 against a cuvette filled with 1.0 M HCl (6.1) as the blank.

Calculations were according to the formula:

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

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

Where
A520 = Absorbance at 520 nm, A280 = Absorbance at 280 nm etc
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 the sample.

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

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

Hydroxycinnamates were calculated as A320-1.4 and Flavonols in the same way as anthocyanins. Malic acid was analysed enzymatically. Data are presented in **Tab. 5.**

Wine making procedures
Winemakers were asked to follow a winemaking procedure lined out by AWC. Wine was taken after ferment according to the following bottling protocol:
For each sample 6 x 750 ml bottles were required. It was ensured that corker/screw capper is clean and operating correctly before taking samples and that the bottles and siphon hose are free from contamination. The bottles were rinsed with a small amount of wine. If the wine has not been sulphured 30 ppm SO_2 (45 gms PMS/750 ml bottle) was added prior to filling to correct level by gentle siphon, minimising splashing by keeping the delivery hose below the level of the wine whilst filling. Bottles were sealed immediately. If inert gas was being used it was ensured that any dry ice has completely dissipated before filling.

Young wine chemical analysis
Six bottles of young wine after fermentation were treated according to protocol in the wineries collected for tasting by the judges and for analysis by 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 420, 520 and 280 nm. A portion of the sample was also treated with acetaldehyde (to bind any residual SO2) and measured at 520nm. This was then used as a correction for the anthocyanin determination (to account for any anthocyanin bound SO2). Results (after correction for dilution) are expressed as Absorption Units, anthocyanins were expressed in mg/L, K in g/L and alcohol in v/v% (**Tab. 6**).
Samples of wine were sent to the Australian Wine Research Institute and tannins were analysed according to Smith (2005), epicatechin was determined according to the formula Epicat. (mg/L) = ((Tannin - 0.0351)/0.01)*40 (40 being the dilution factor).

Wine assessments
On September 4th 2007 wines were assembled, bagged and randomly numbered and judged by David Lloyd from Eldridge Estate, Geoff Duke form Duke Vineyards, Owen Goodwin from Morning Sun Vineyard, Tod Dexter from Yabby Lake Vineyards and Matt Aldridge from AWC according to a mutually agreed set of descriptors. For each descriptor and the wine show score an average was taken over the judgements from the 5 tasters (see Tab. 7b), and incorporated into **Tab. 7**. Free connotations were also taken for every wine and their abbreviated summaries included in **Tab. 7b**.

Group presentation
A group meeting in the region was organised by Kieran Murphy and Grapecheque on 26.10. 07. An overview of the results was presented EW, DB and MA and all participants received all wines for tasting. Each participant received this report a week beforehand with a note to what code their vineyard was booked under. A mutual consensus was reached on the emphasis of next season"s work.

Results

The climate

The monthly average maximum and minimum temperatures in the season 06/07 were considerably hotter than last year.

Fig. 1: Average monthly maximum temperatures in 05/06 with long term survey (right graph) and 06/07 (left graph) from Cerberus in the Mornington Peninsula.

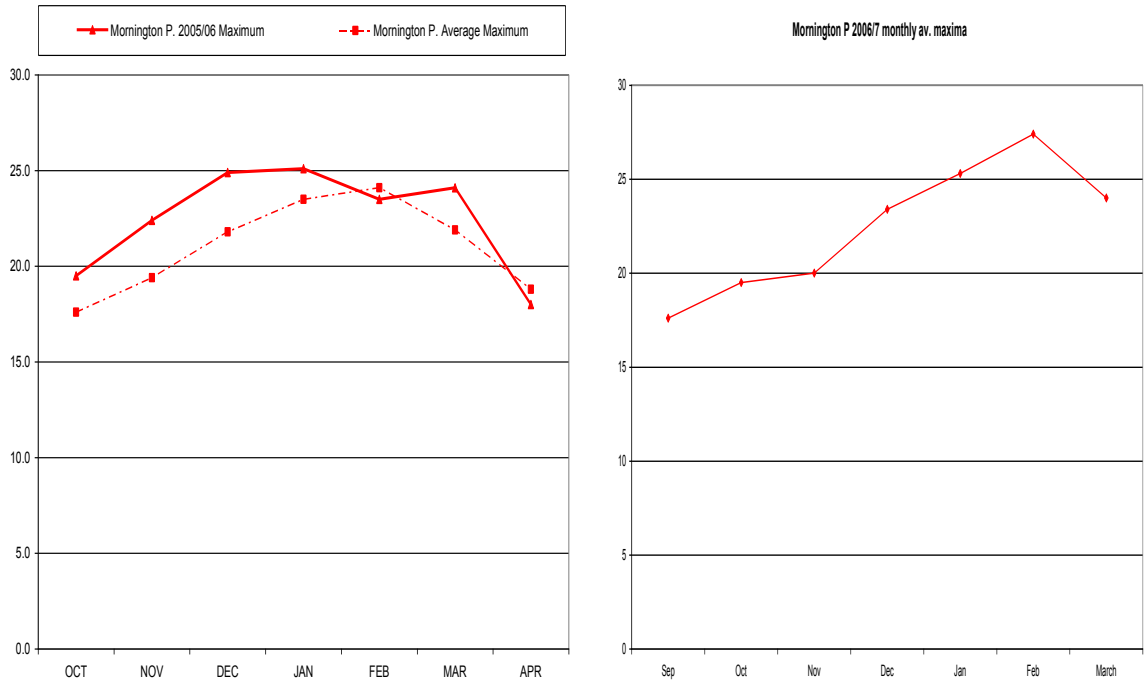
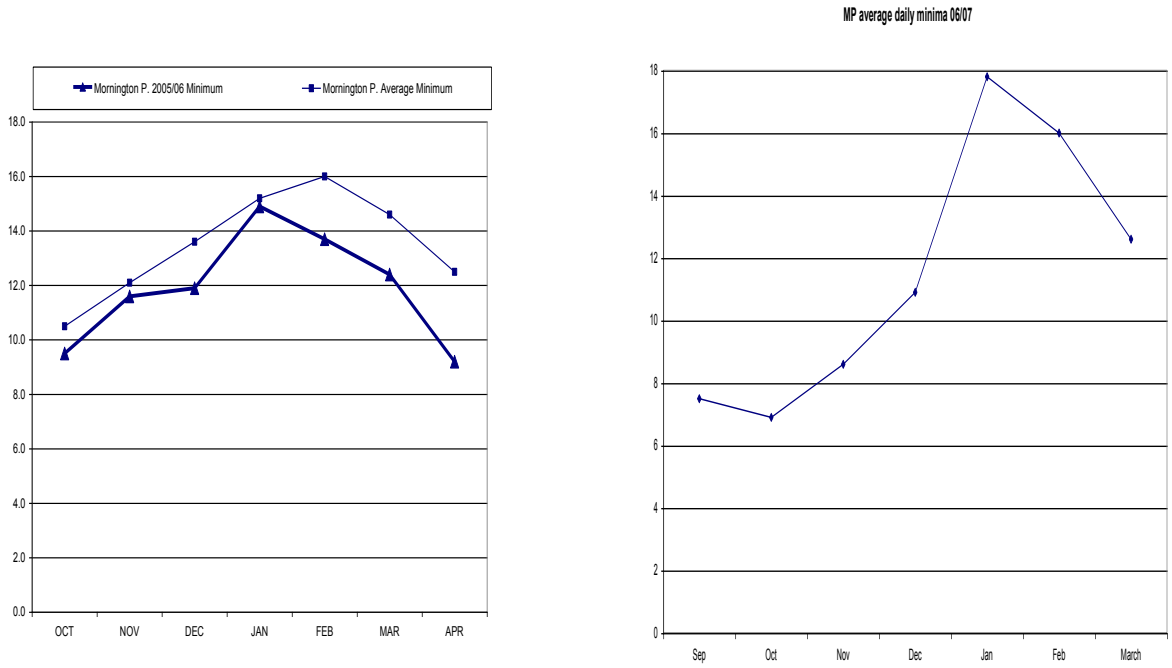


Fig. 2 Monthly average minimum temp.



In the Mornington Peninsula rainfall in 06/07 was below average and less then last year.

Fig. 3: Rainfall 05/06 at Stony Point, Mornington Peninsula vs average

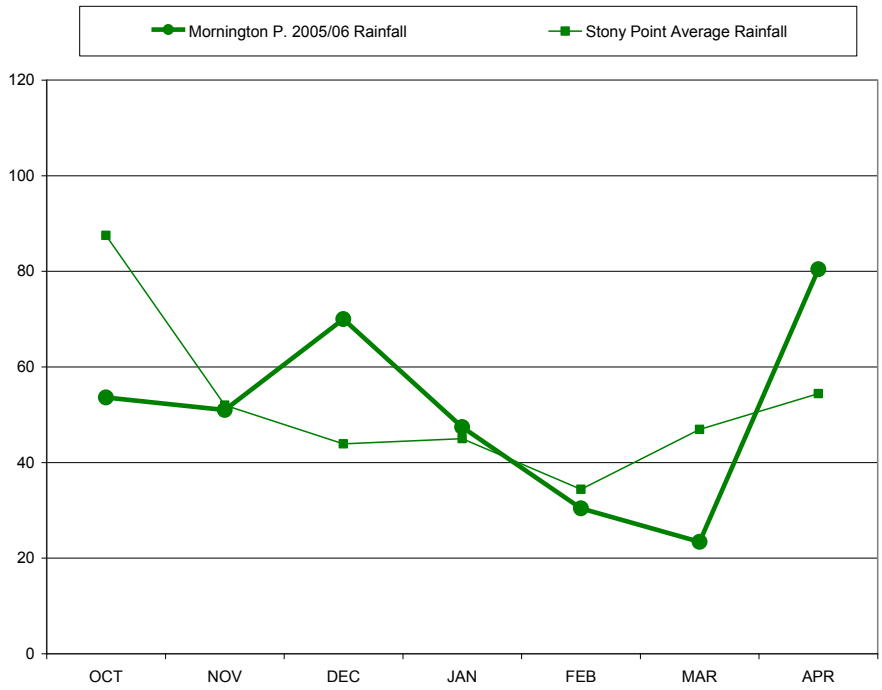
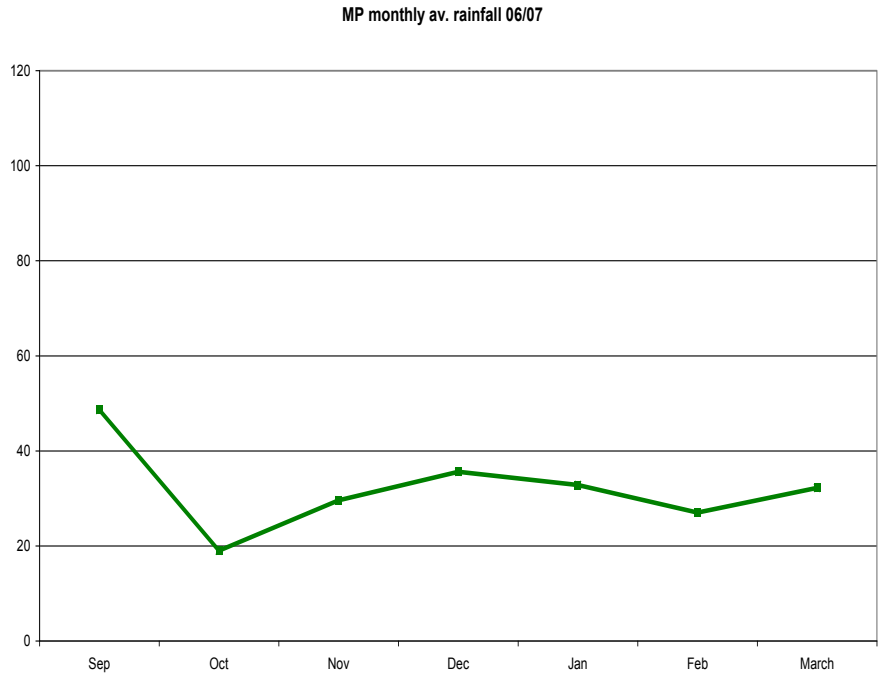


Fig. 4: Rainfall 06/07 at Cerberus, MP



The vineyard information

As can be seen from **Tab. 1** there is quite a variety of locations, aspects, elevations, soil types and slopes. Vineyard blocks were chosen to all be on their own roots and mv6 clones. Vineyard codes are the same as last year. In 2006/07, the season started with a dry winter and early budburst. Cool spring conditions were experienced, with some hail and frost in pockets in October and November. Conditions resulted in poor fruitset for some vineyards which ultimately resulted in reduced yield in some parts of the region. A little rain in Jan and Feb helped maintain vine canopy health but dry conditions late season contributed to low yields due to low berry weights.

The vineyard assessments

Table 2 shows the assessments made in the vineyards at veraison and at harvest as an average for 20 representative shoots. Less shoot trimming happened than last year. Eight vineyards had leafy vines (active leaf area more than 2000 cm^2/shoot, which is more than last year (3 out of 17).). Vine balance assessments ranged from 8 -28 (last year from 8-22). More vineyards had a higher vine balance (>20) this season. Previous work by *Iland and Fetzman, (2002)* indicated that 25 would be needed to adequately ripen Pinot in a cool climate.

Fig. 5a: Many vineyards had higher vine balance values in 2007, which were slightly but not significantly related to leaf area.

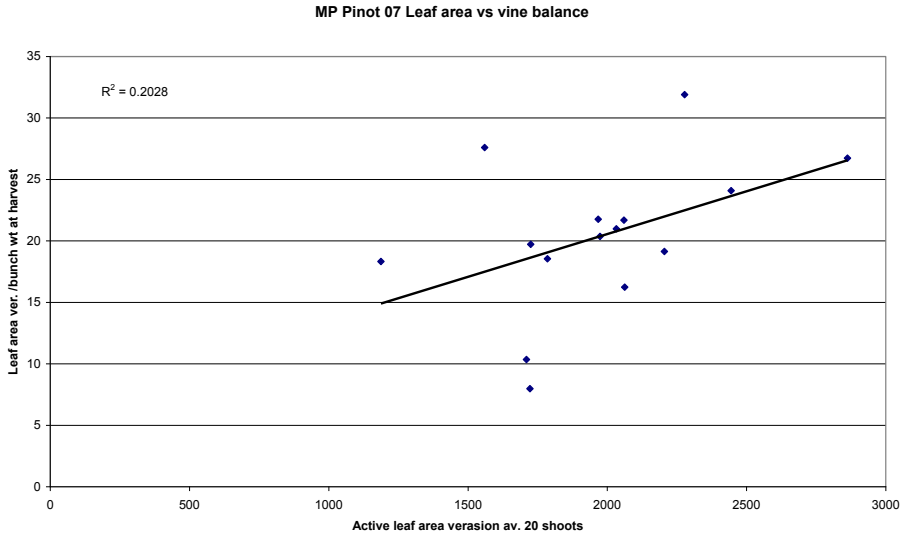


Fig. 5b: Vine balance at veraison was in 06 influenced by leaf area.

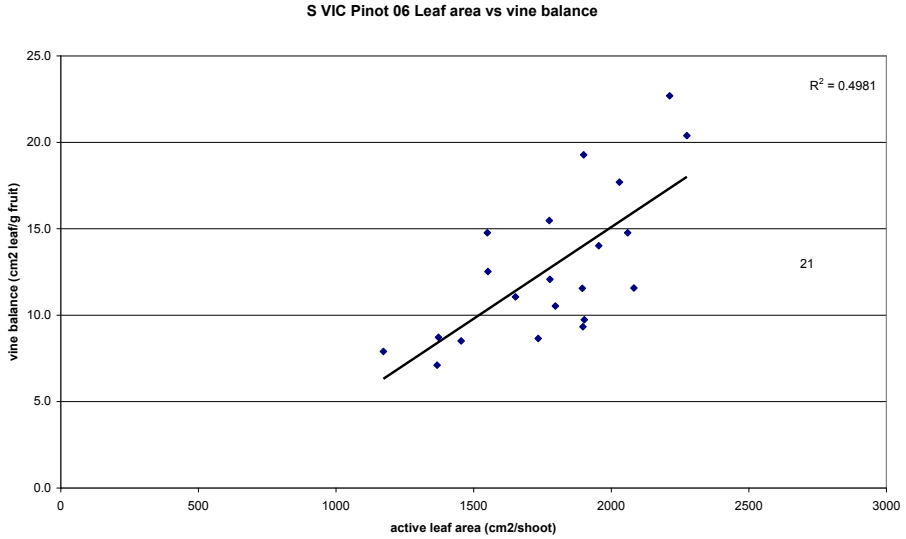
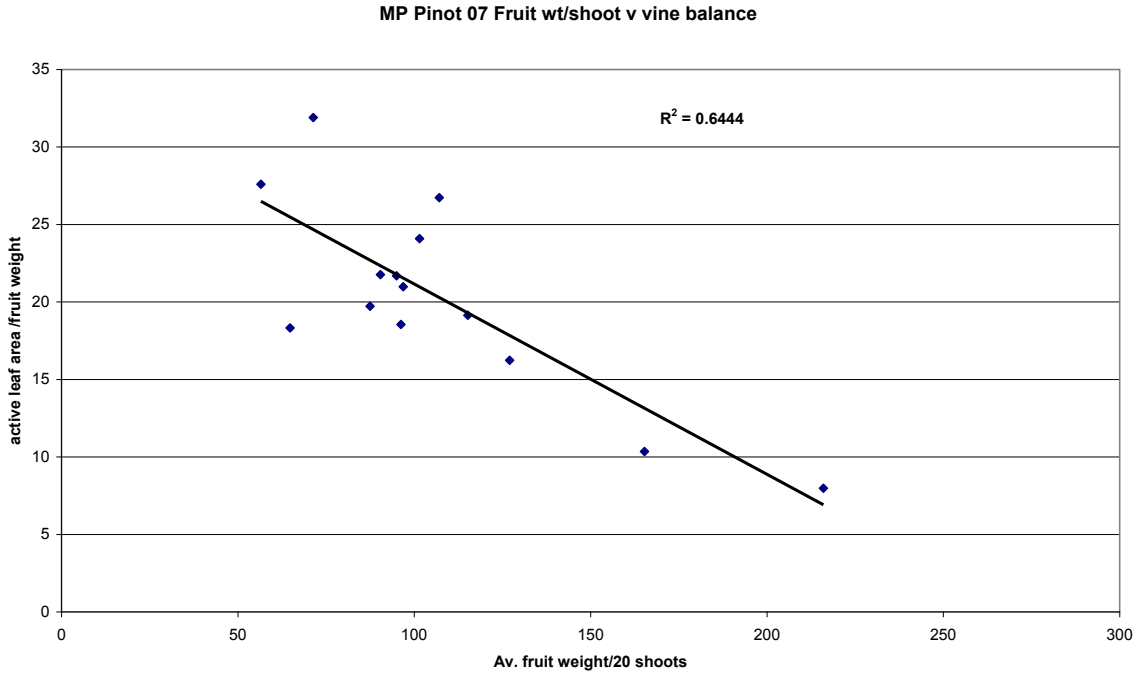
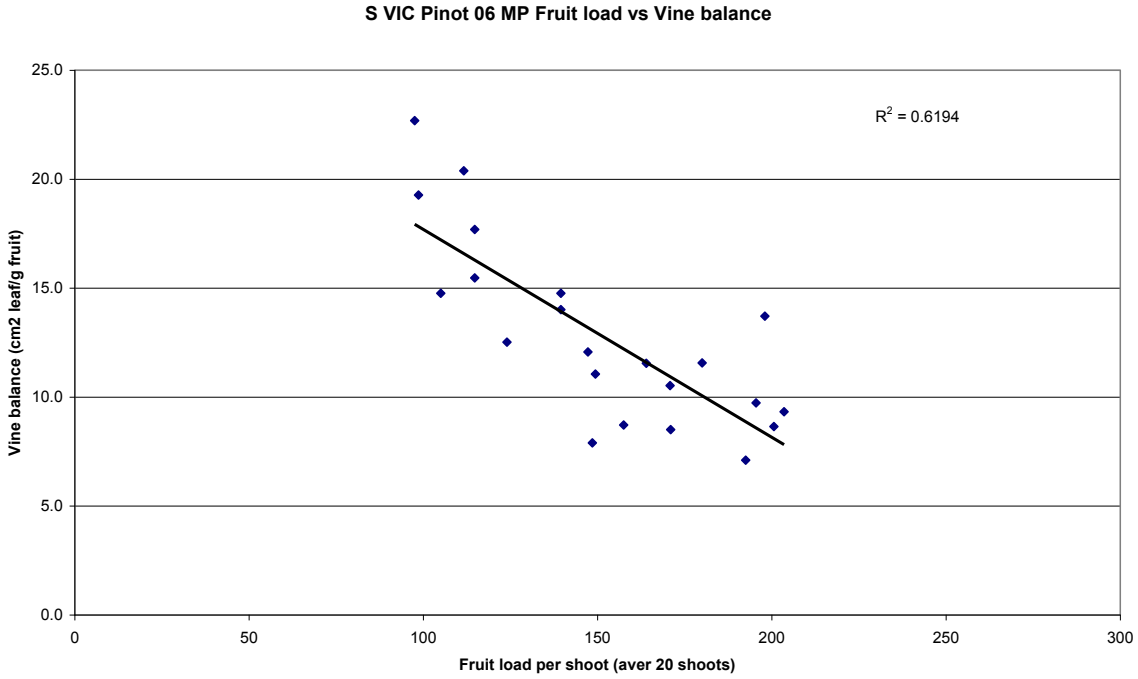


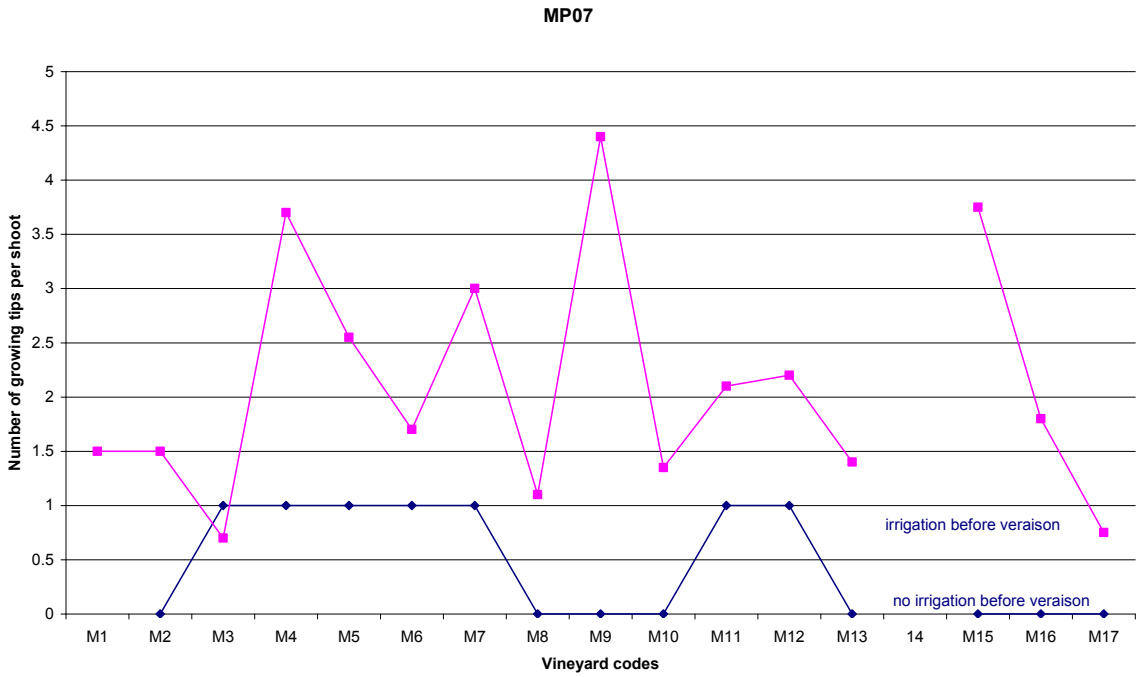
Fig. 6a,b: Vine balance was in 07 and 06 significantly influenced by fruit load with lower fruit weights in 07





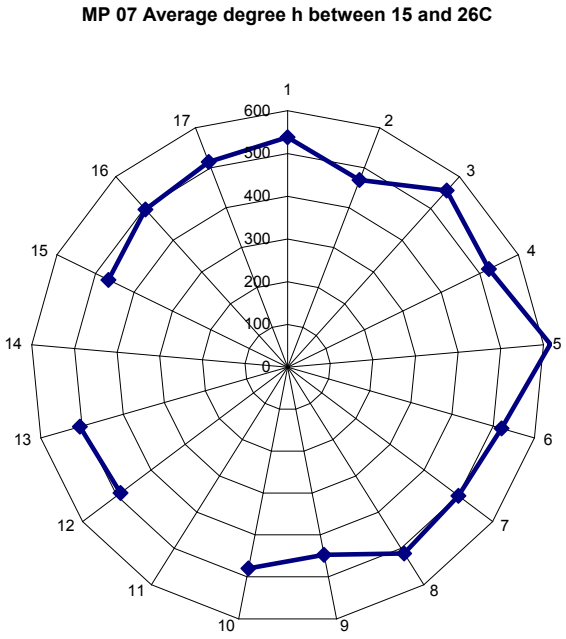
In both years vine balance had no significant influence on cane lignification.

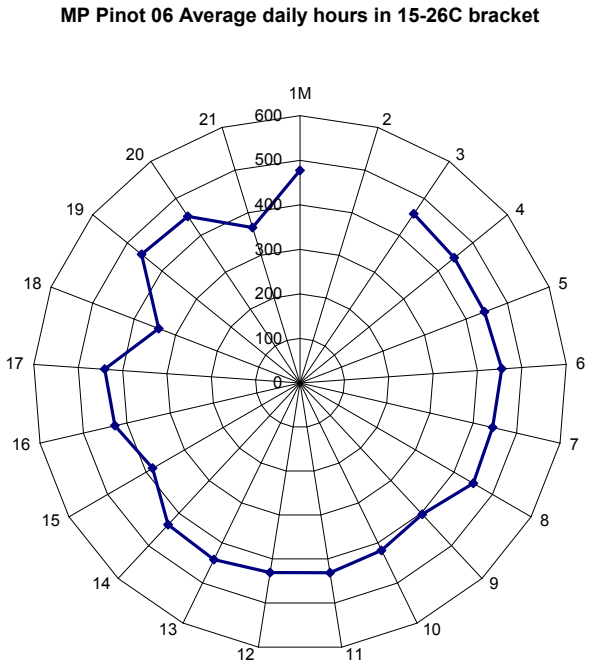
Fig. 7a,b: Vine growth (eg number of growing tips per shoot) was not always related to irrigation but mainly caused by tipping. 20 It should be noted that most vineyards indicated minimal irrigation inputs.



Bunch zone Temperatures

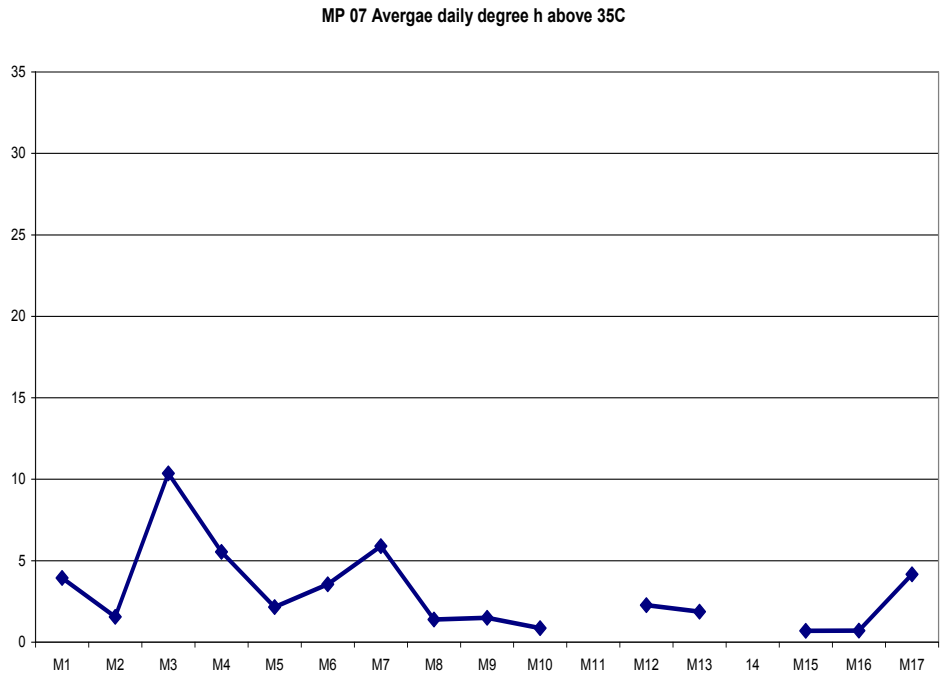
Fig. 8 a,b: Daily average amount of degree hours in the beneficial temperature bracket 15-26C were more numerous in 06/07 (above) than in 05/06 (below). (Numbers are vineyard codes)





As can be seen in **Tab. 3**, all vineyards increased the percentage of hours in the beneficial bracket.

Fig. 9a, b: Daily average degree hours of bunchzones above 35C was different for the same vineyards in 06/07 (above) vs. 05/06 (below), with some bunchzones having lower heatloads in 07 despite the hotter end of the year.



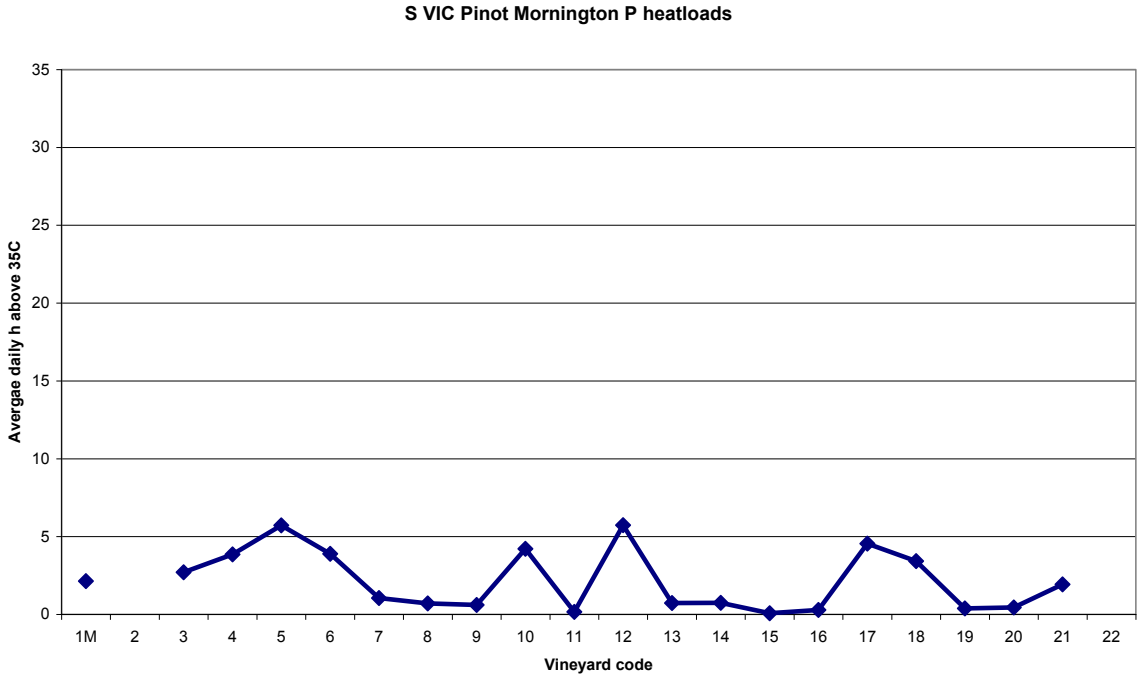


Fig. 10a: **Cumulative degree hours of bunchzones below 15C were much lower in 07 compared to 06.**

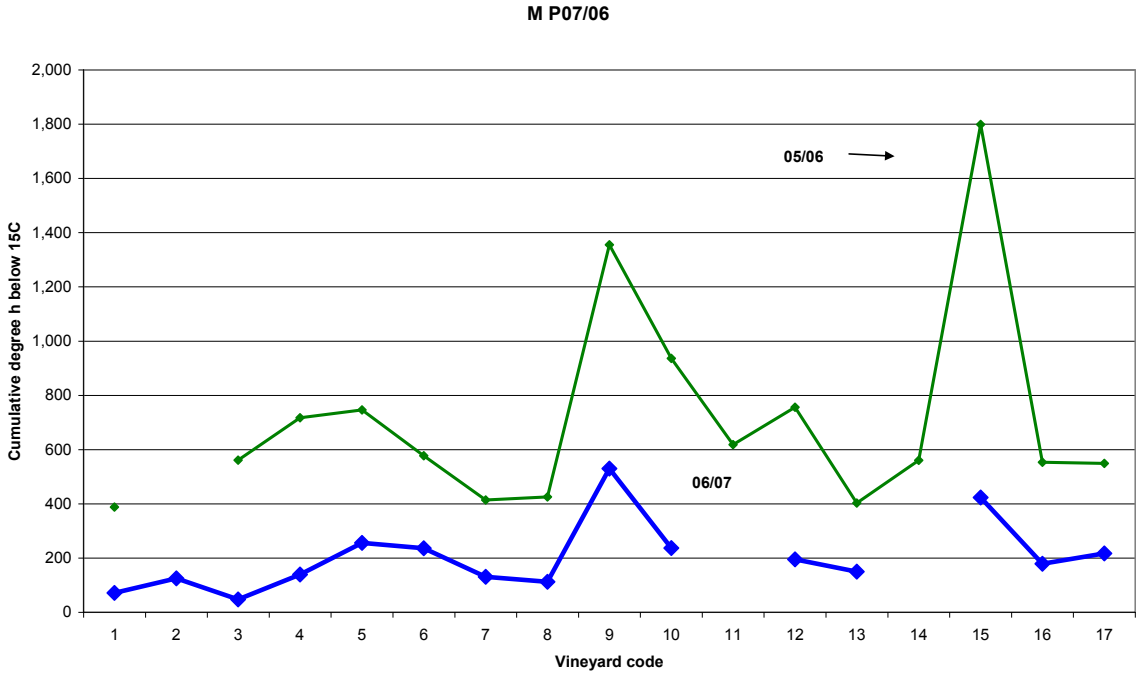


Fig. 10b: **Cumulative degree hours above 35C were not always higher in 07 than in 06! Vineyards 5, 10 and 12 have considerably lower heatloads than last year. Vineyards 3 and 7 have more heatloads. This is due to management practice *and* hangtime.**

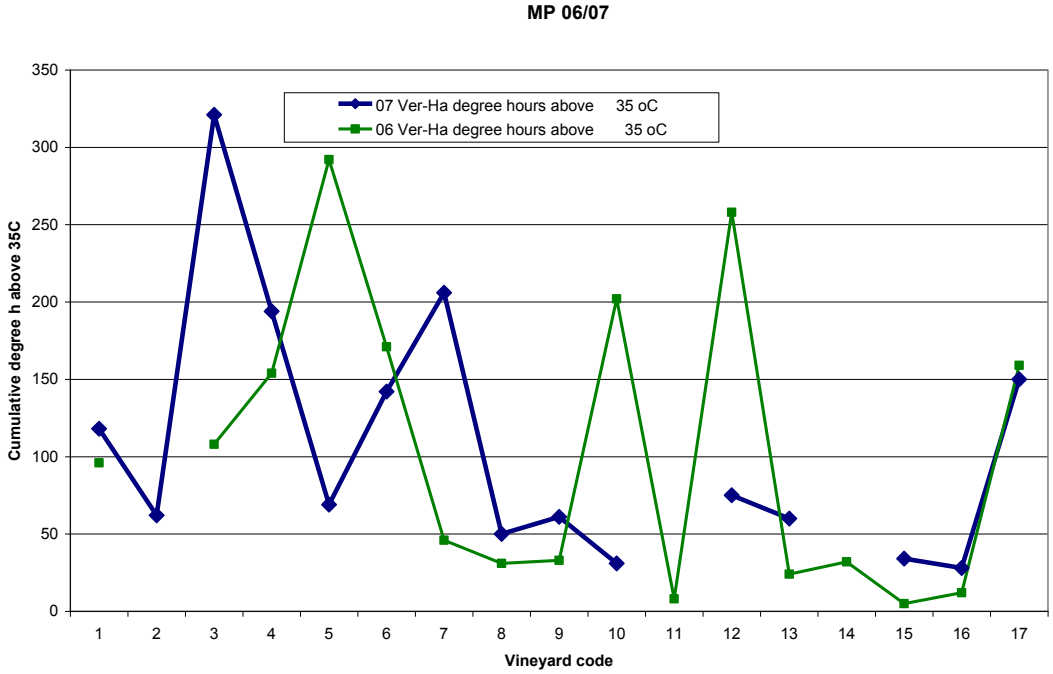


Fig. 11: Cumulative degree hours of bunchzones base 0C were (with 5 exceptions) lower in 07 compared to 06, mainly due to shorter hangtimes.

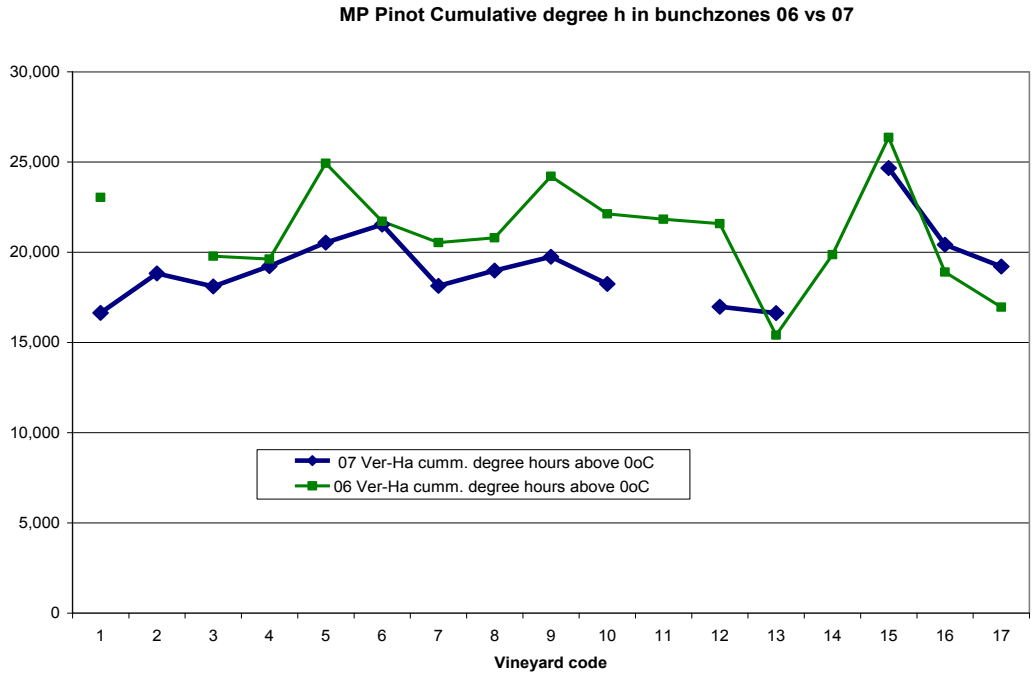
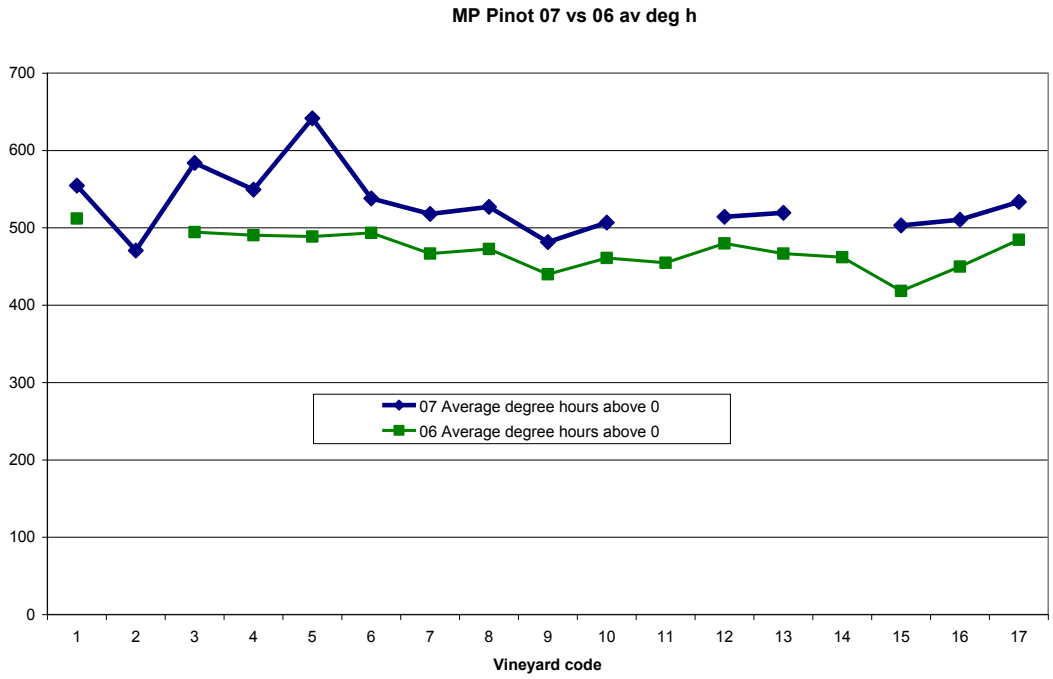


Fig. 12: Average daily degree hours of bunchzones base 0C were higher in 07 compared to 06 mainly due to warmer weather.



Single vineyard profiles

Data loggers were placed in the bunchzones in representative spots and initiated at veraison or shortly after. Data loggers are inexpensive and not difficult to mange and enable learning and adoption of best practice.

Dataloggger curves were employed to help each vineyard to see the diurnal fluctuation of bunchzone temperature, the maximum heatloads, the night lows and the general bunch climate.

Bunchzone temperature is not the sole determinant of producing excellent grapes and wine, however knowing it over several seasons can help to minimise the detrimental effect of hot years through canopy management and maximise use of trellis and shoot position for best grape and wine outcome.



Fig. 13: Temperature data logger nailed to the post in the bunchzone of a Pinot noir row.

1M Bunch zone n/e facing side of row



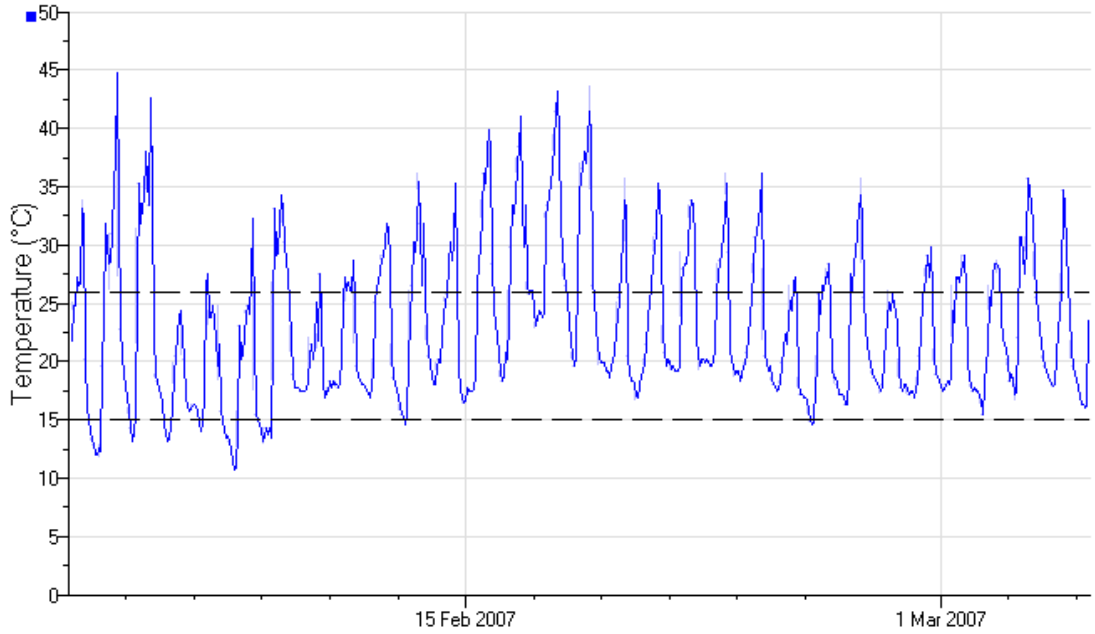
1M Bunch zone facing s/w

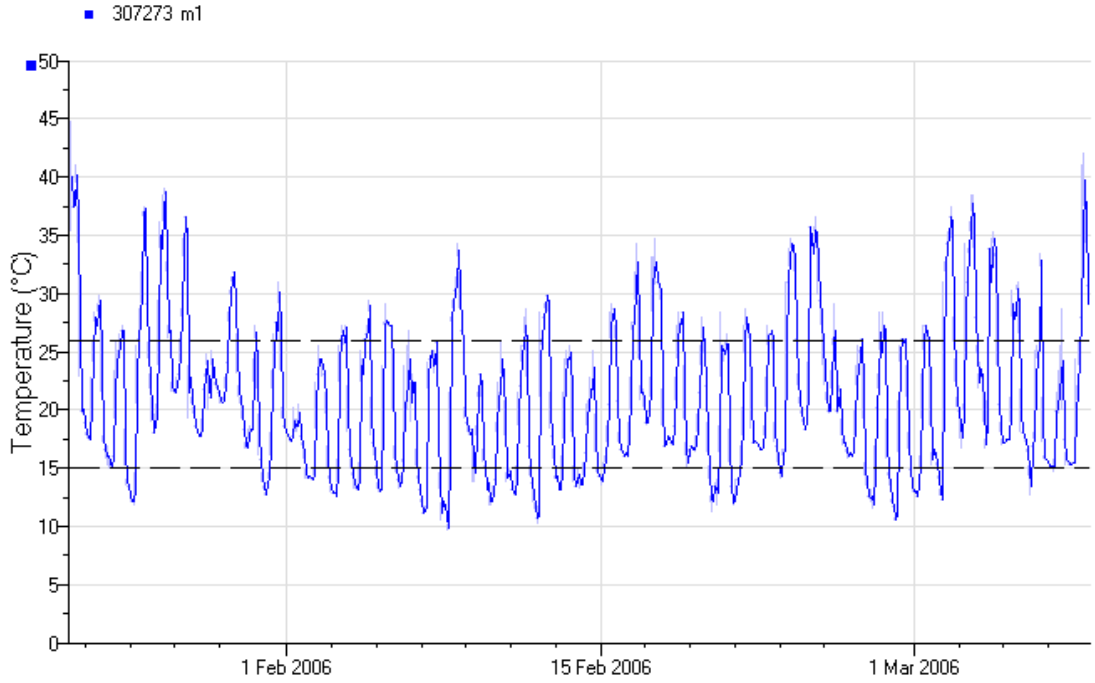


M1 at harvest

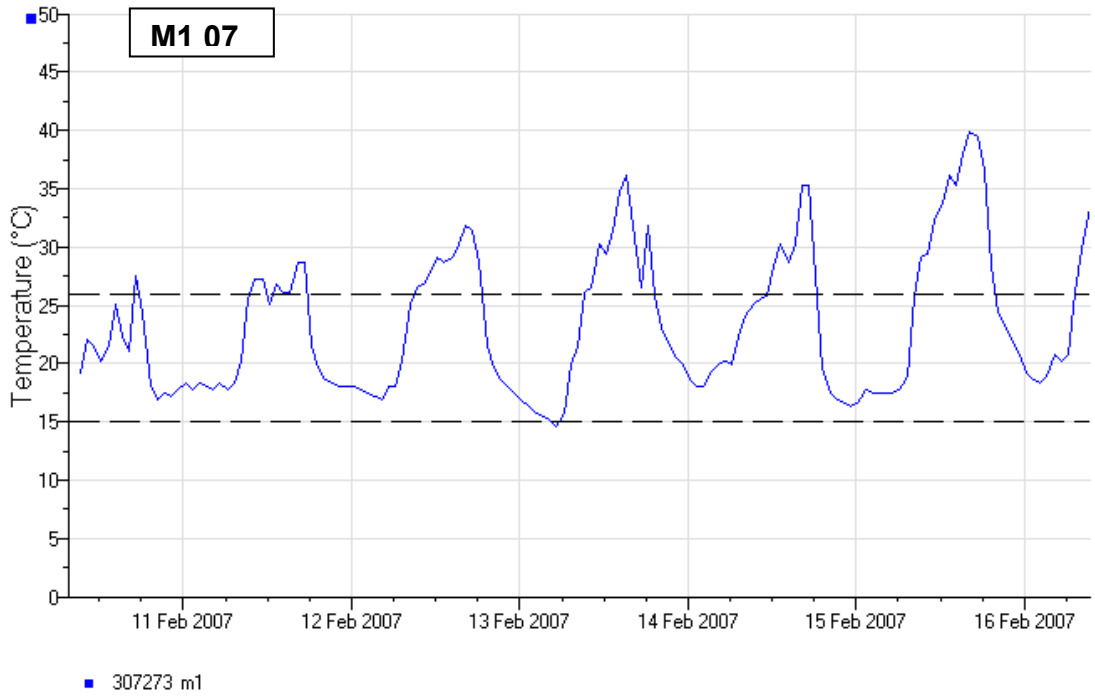


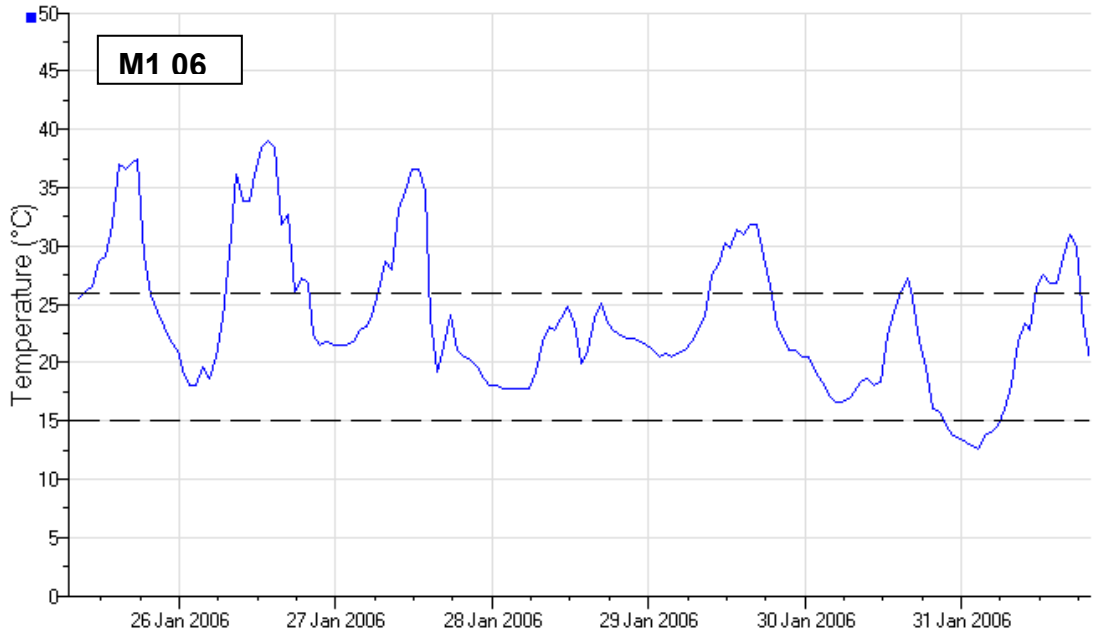
1M Bunch zone temperatures 06/07 ver- harv. 30 hangtime, warmest bunchzones





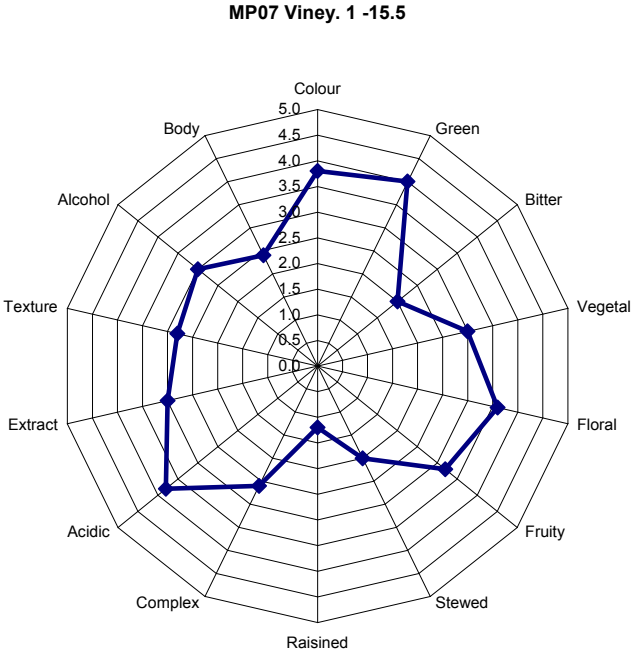
1M Bunch zone temperatures ver- harv. 05/06


M1 07
Temperature (°C)
0
5
10
15
20
25
30
35
40
45
50
11 Feb 2007
12 Feb 2007
13 Feb 2007
14 Feb 2007
15 Feb 2007
16 Feb 2007
307273 m1


M1 06
Temperature (°C)
0
5
10
15
20
25
30
35
40
45
50
26 Jan 2006
27 Jan 2006
28 Jan 2006
29 Jan 2006
30 Jan 2006
31 Jan 2006

07: small berries, 2 with mealy bug, light fresh juice with sour/bitter skins, seeds only have a trace of green.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
1	29		0.63	3.8	5.7	22.6	12.6	0.75	1.06	0.32	2.2	2.0	3.0	2.8	2.3	2.0



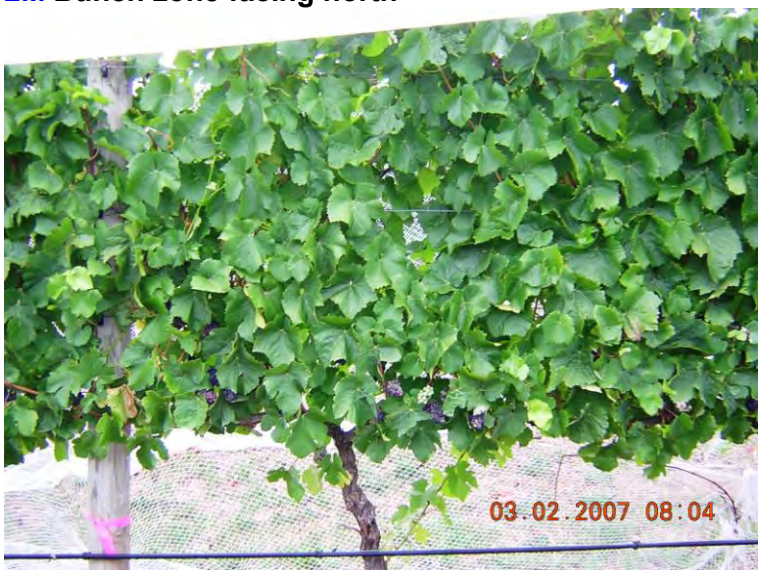
06: Small berries with high acid and grassy skins, no wine

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
7.9	4.1	shrivel	14.8	0.81	3.0	3.0	2.5	2.3

2M canopy facing south



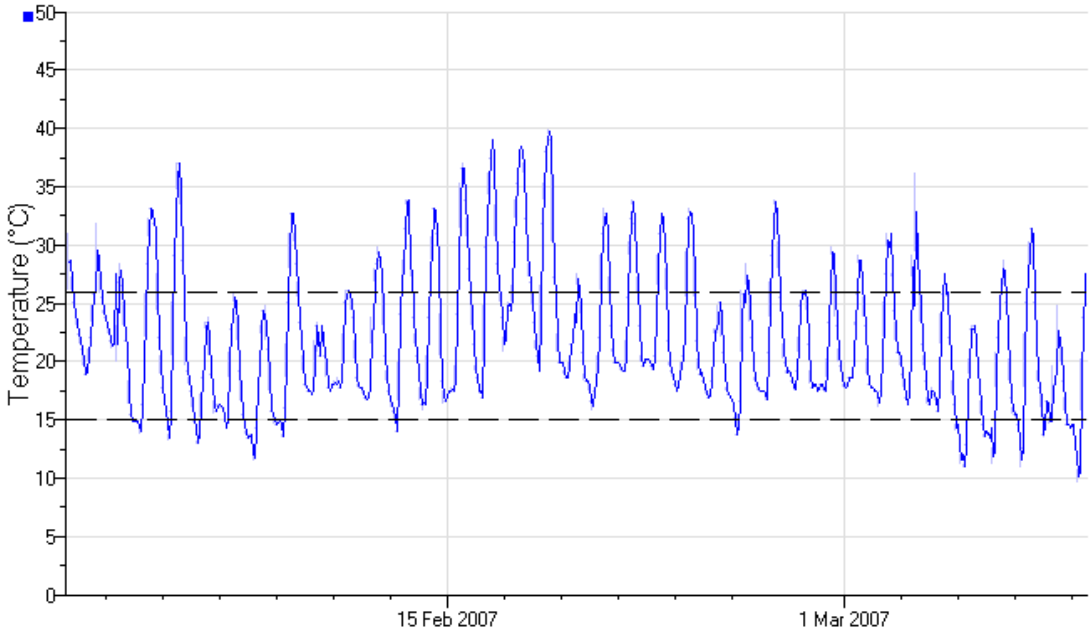
2M Bunch zone facing north



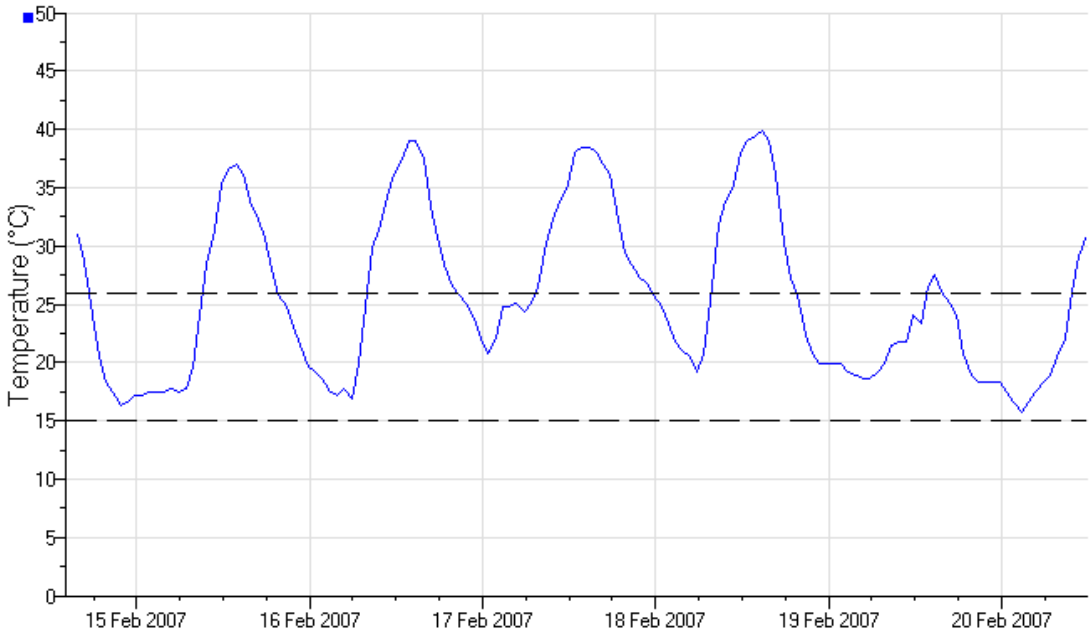
M2 at harvest



2M Bunchzone temperatures 07



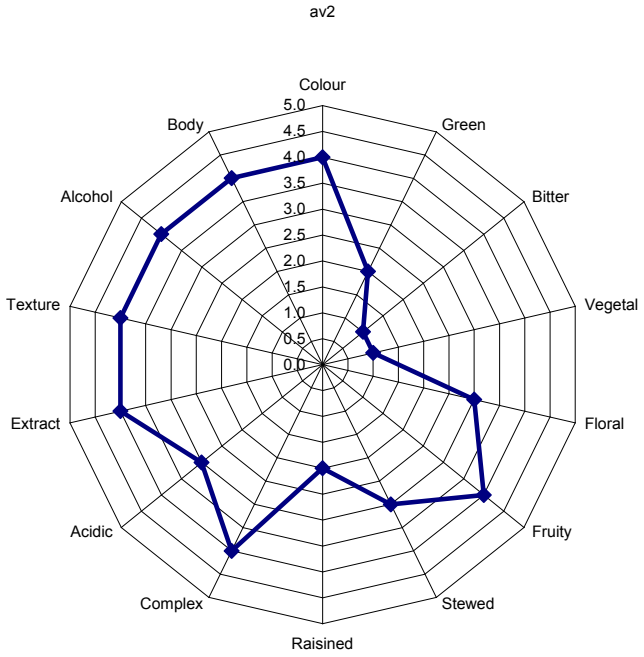
2M Enlarged bunchzone temperatures hot spell 07



No bunchzone temp from 06

07: clean sample, sugar/acid balance with flavour intensity and ripe skin flavour/tannin.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
2	35		0.93	3.7	6.1	23.7	13.2	0.70	0.92	0.25	2.0	2.7	3.0	3.0	2.7	2.7



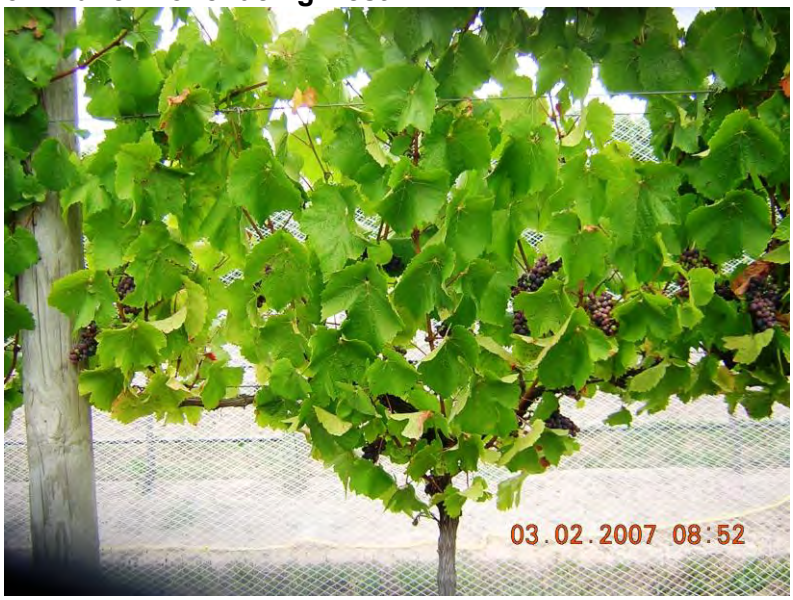
06:

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
8.6	3.8	sh	13.2	0.93	2.6	3.0	2.0	2.0

3M North –south rows not many young leaves canopy facing east



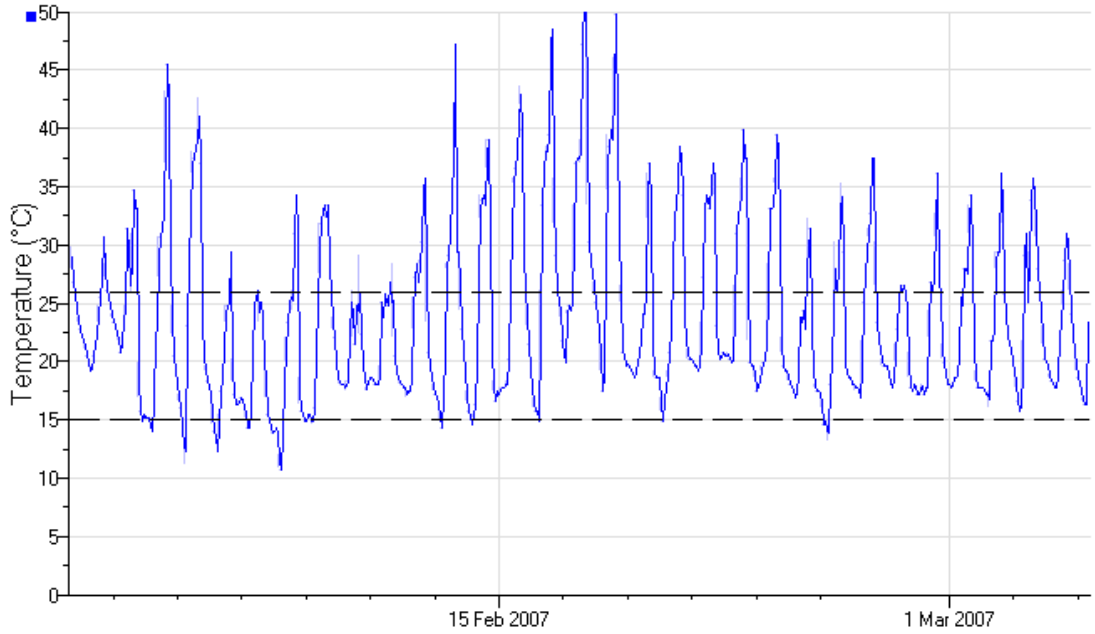
3M Bunch zone facing west



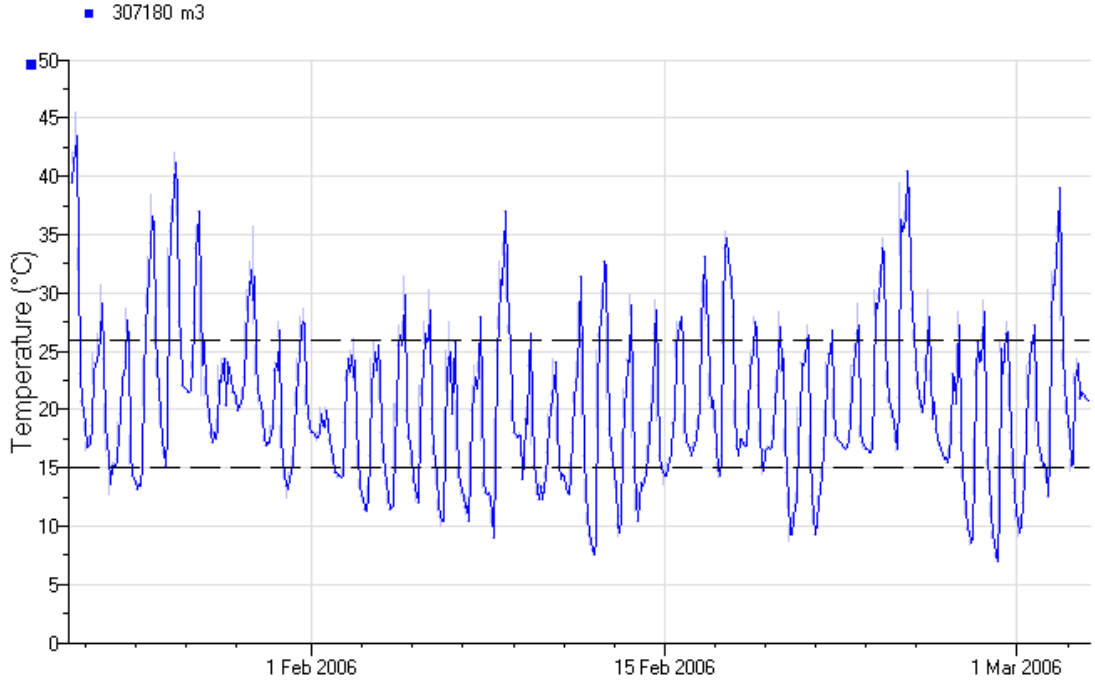
3M at harvest



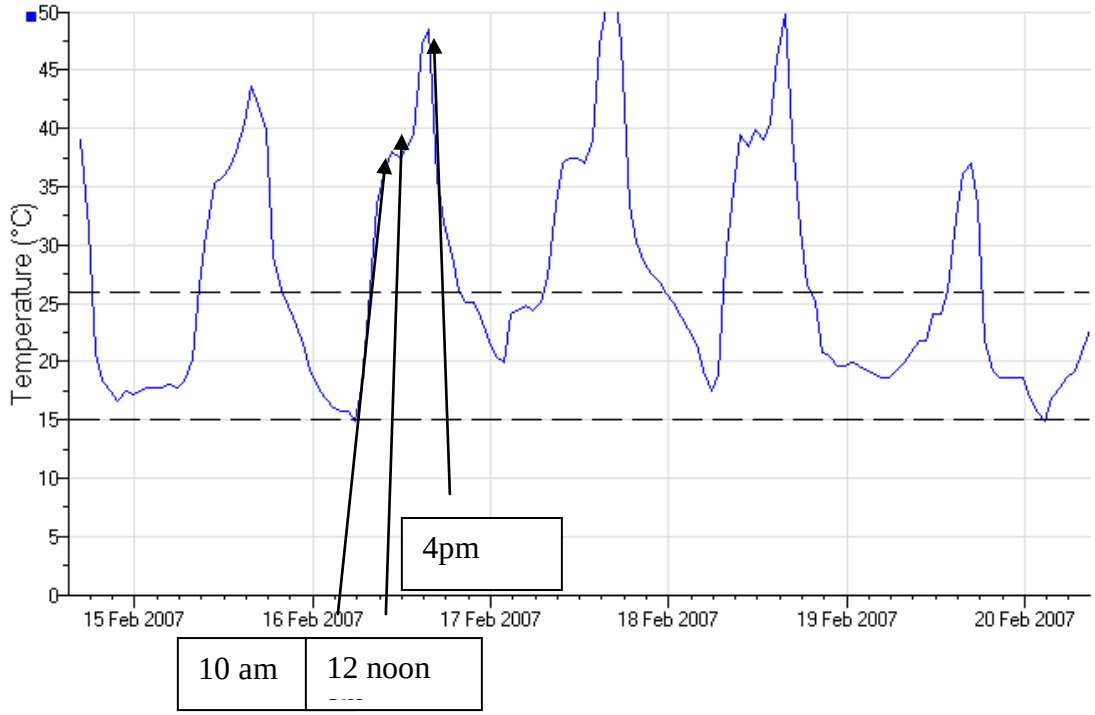
3M Bunch zone temperatures ver.-har. 07



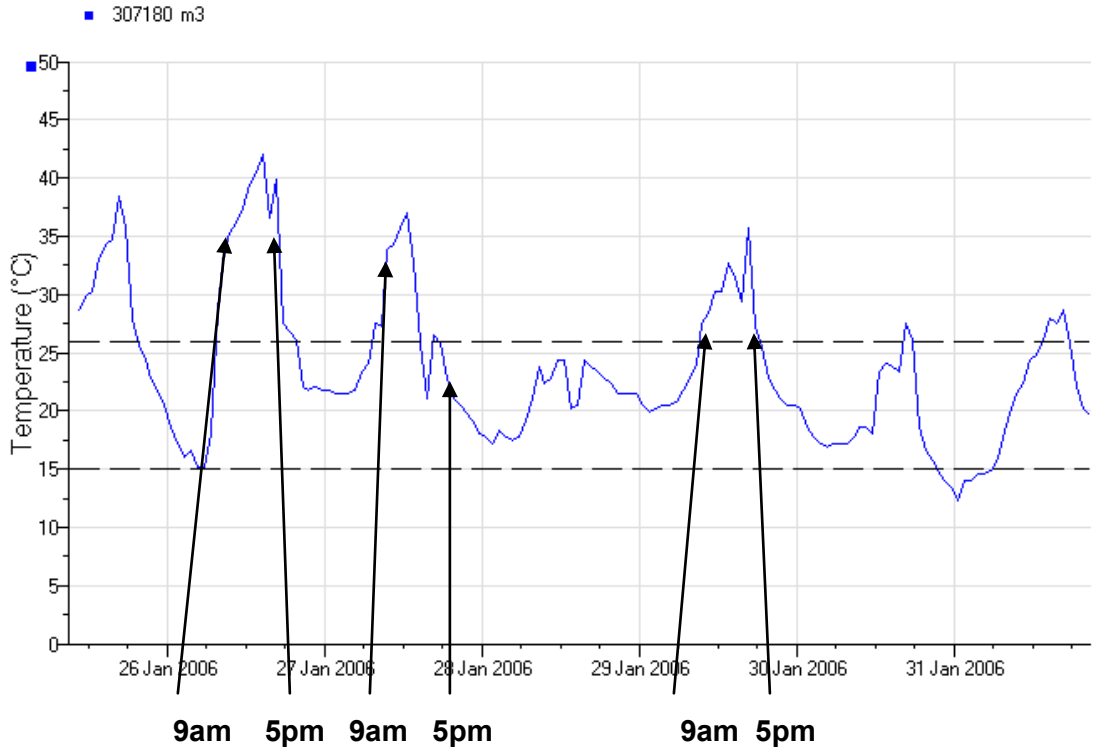
3M Bunch zone temperatures ver.-har. 06



3M Bunch zone temperatures summer 07 High exposure to east and west



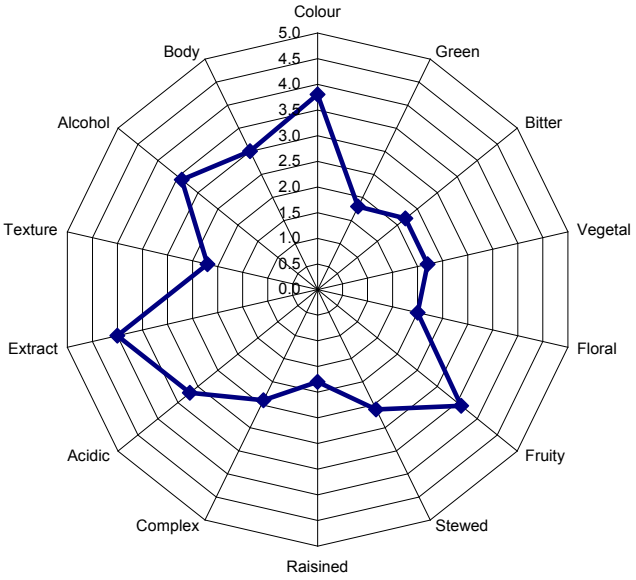
3M Bunch zone temperatures summer 06 Exposure more to west than to east (see leaf cover) data



O7: clean sample, some raison berries, fresh plum flavours and herbaceous/bitter skins.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
3	29		0.75	3.8	5.4	23.8	13.2	0.85	1.13	0.35	2.0	2.2	3.0	3.0	2.3	2.8

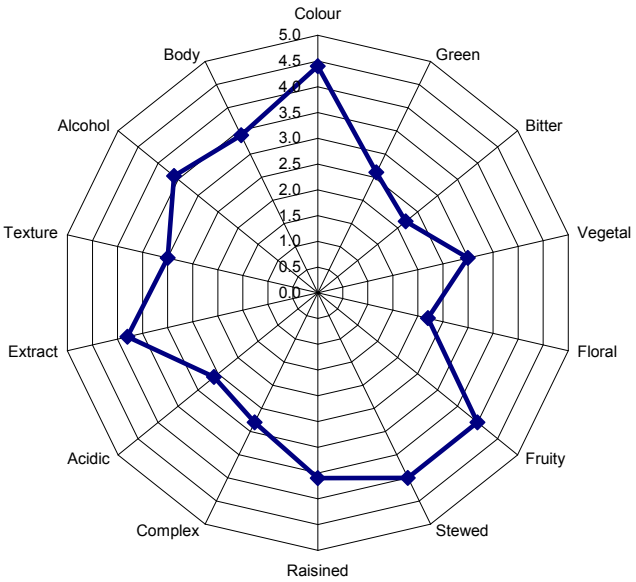
MP07 Vin 3 - 15.6



06 Coarse skin tannins, shrivel. Ants earwigs??

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
7.4	4.0	sh	13.6	0.93	3.0	3.0	2.0	2.0

M3 16.4



4M NS Row Canopy facing east



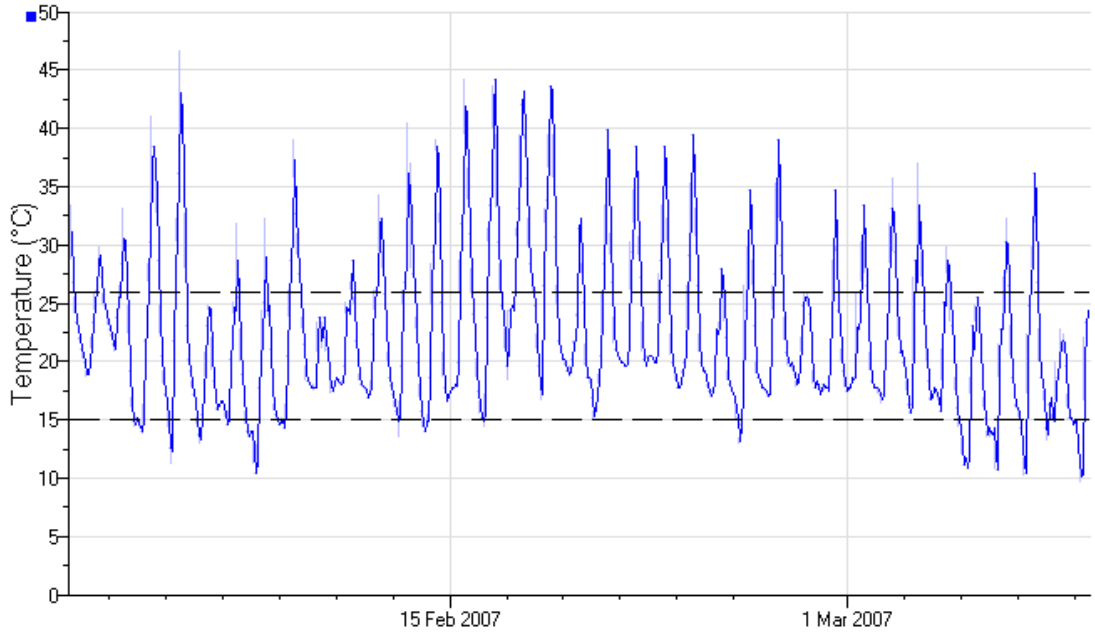
4M Bunch zone facing west.



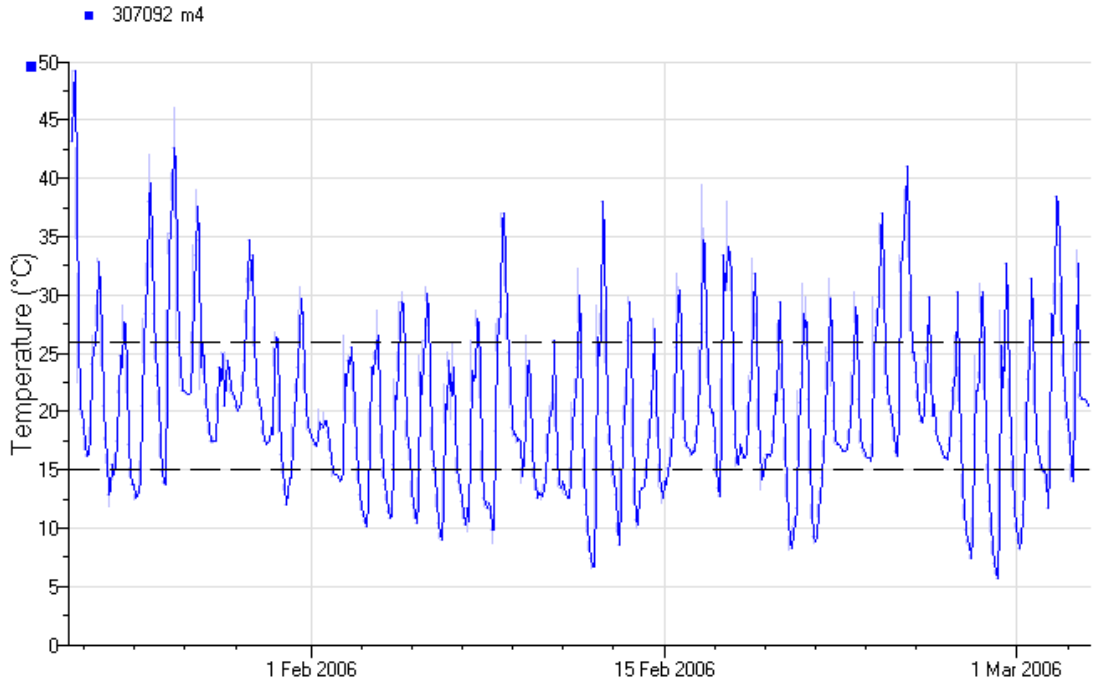
4M Bunch zone at harvest



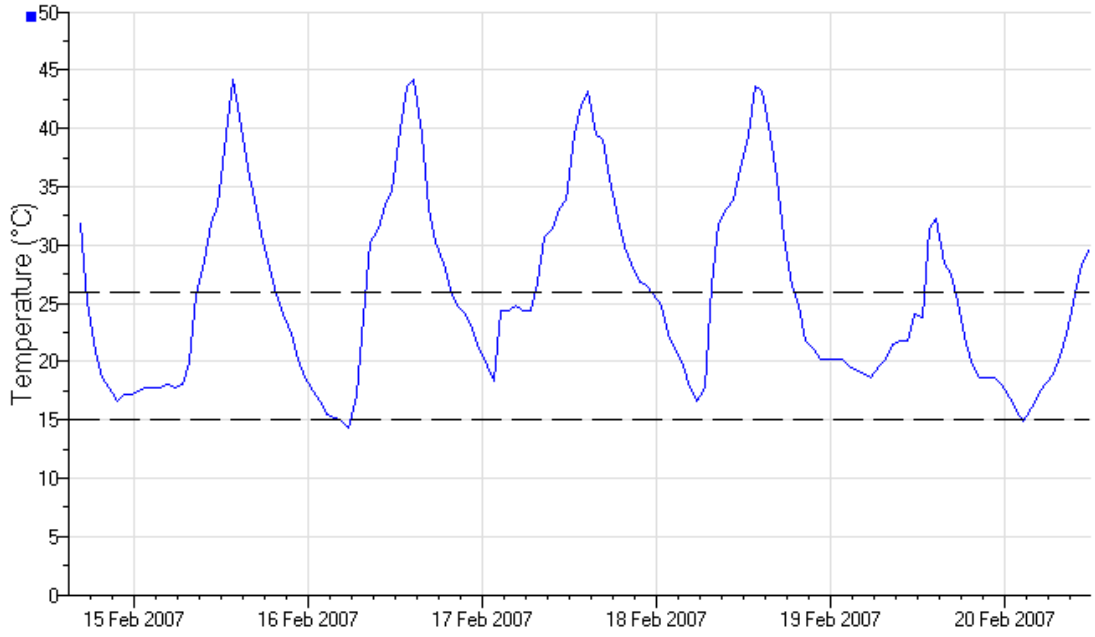
4M Bunch zone temperatures 07



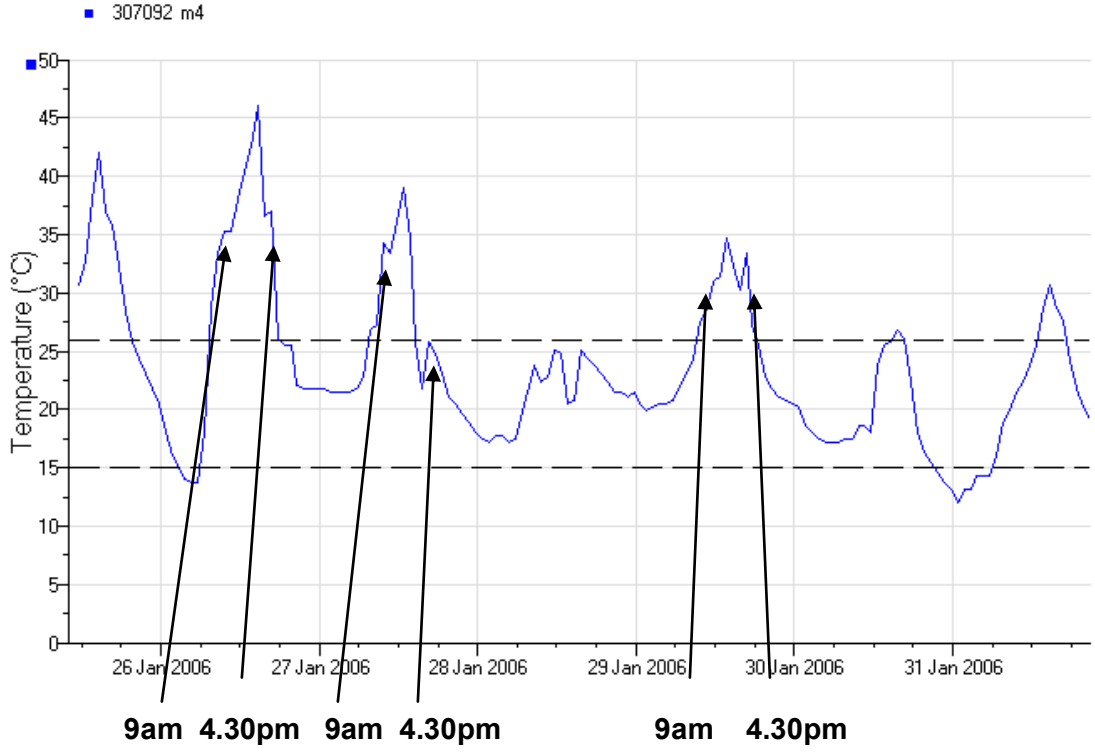
4M Bunch zone temperatures 06



4M Bunch zone temperatures summer 07



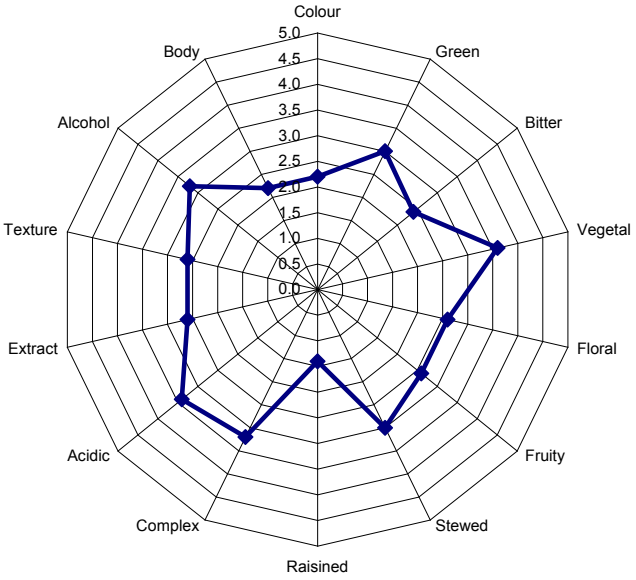
4M Bunch zone temperatures summer 06



07: clean sample, varied flavours with low acid, grassy/sour skin tannin.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
4	35		0.61	3.9	5.7	20.8	11.6	1.01	1.09	0.37	2.8	2.2	3.2	2.7	2.0	2.5

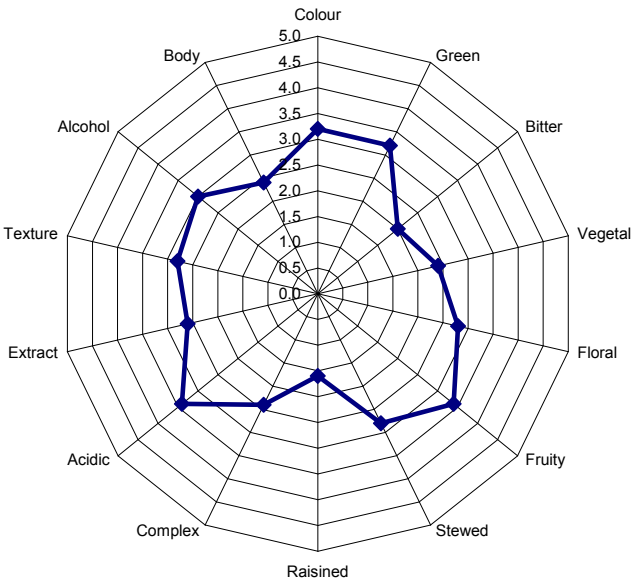
MP07 Vin 4 14.0



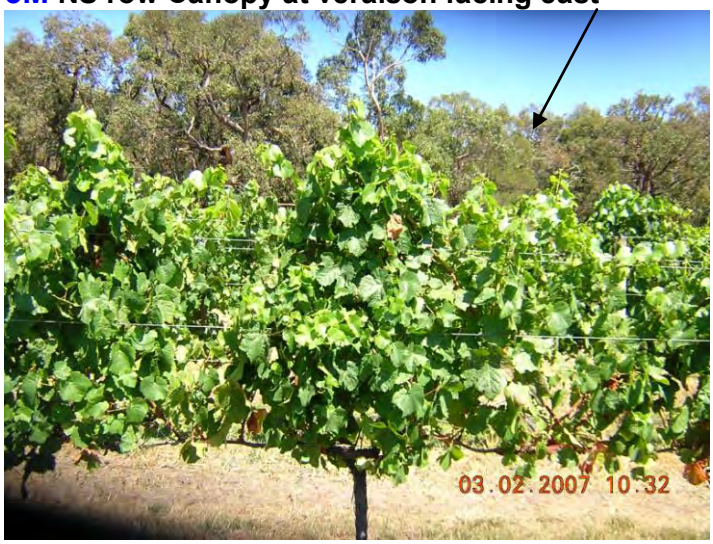
06 Small berries some raisined low acid fresh light pulp

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
5.5	4.0	raisin	13.3	0.71	3.2	3.0	2.3	2.6

M4 15



5M NS row Canopy at veraison facing east



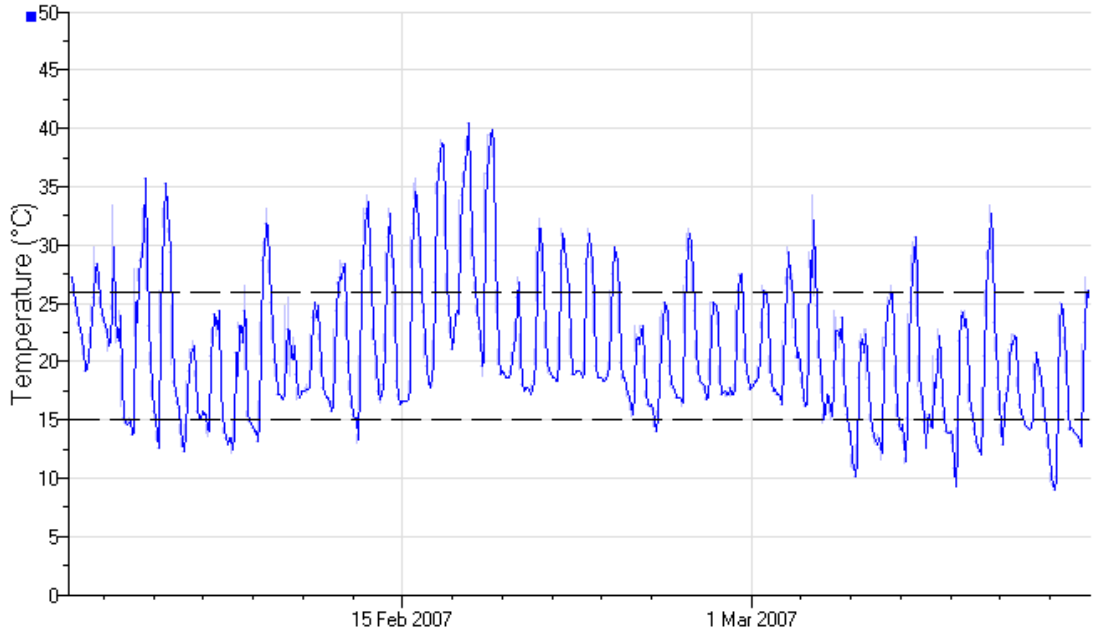
5M Bunch zone facing west



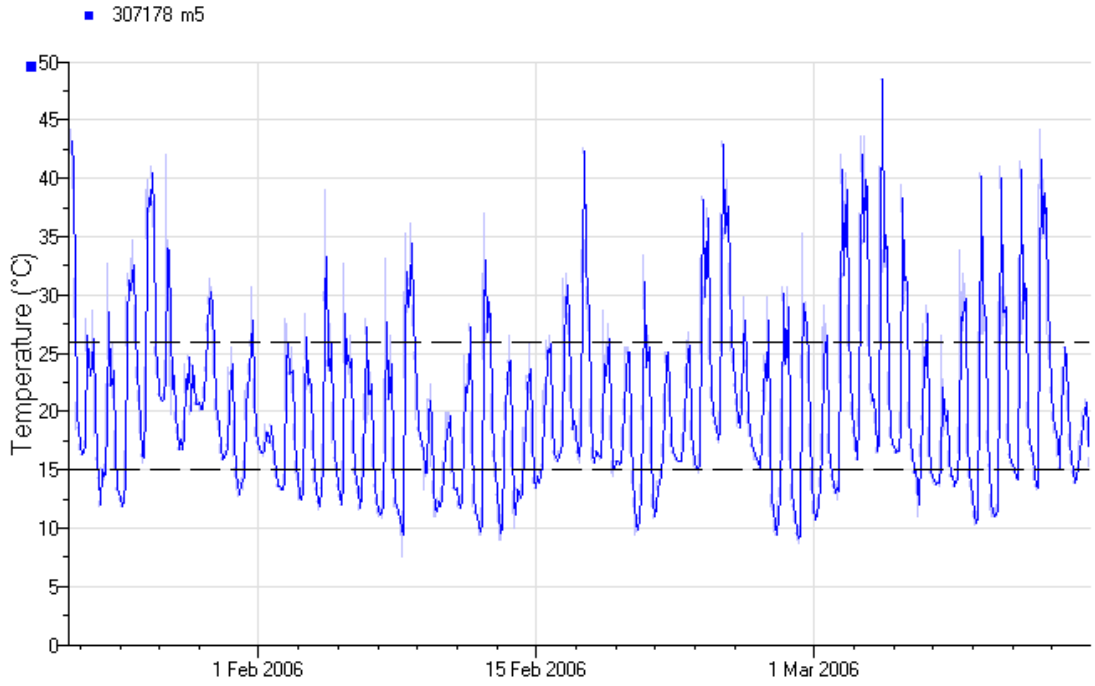
5M Bunch zone pre harvest



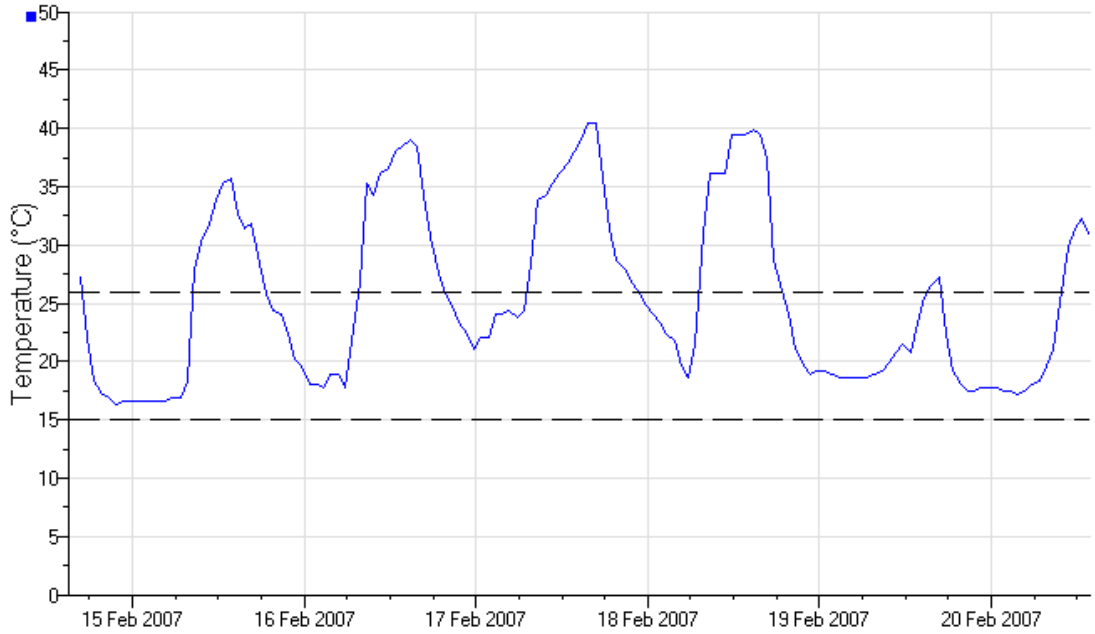
5M Bunch zone temperatures 07



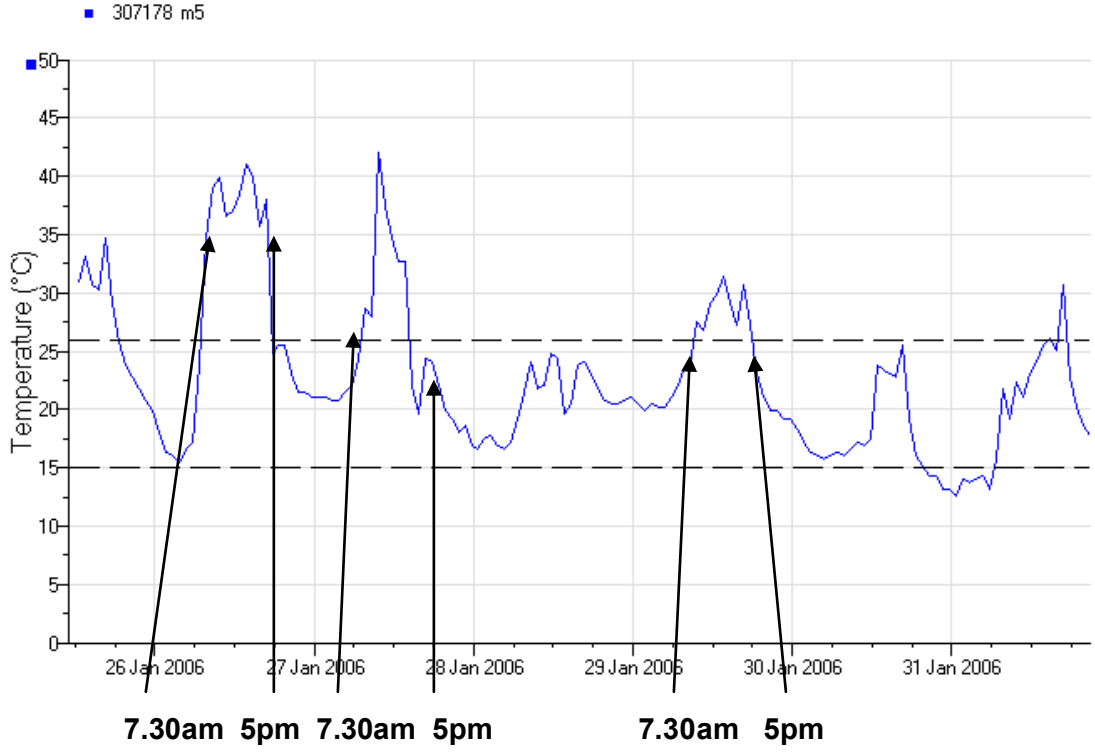
5M Bunch zone temperatures 06 warm bunchzones with some heatloads



5M Bunch zone temperatures summer 07



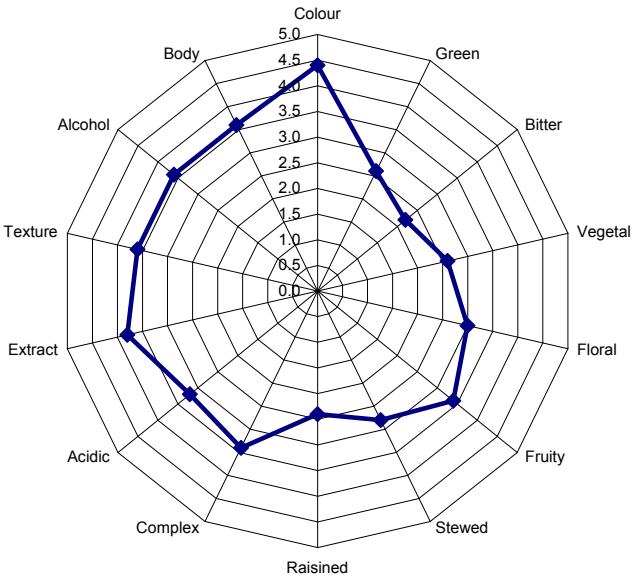
5M Bunch zone temperatures summer 06



07: clean sample, large bunches, varied berry size, **some shrivel,** grassy tannins.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
5	36	some	0.79	3.8	5.7	23.8	13.2	1.31	1.09	0.43	3.0	2.5	3.0	3.0	2.3	2.3

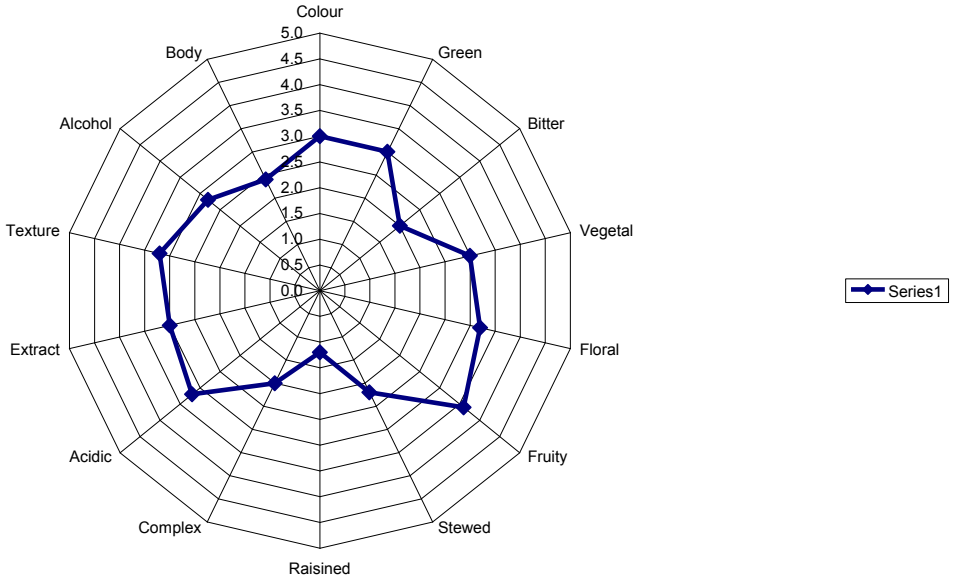
MP07 Vin 5 -16.5



06: Pulp intense, skin grassy

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
6.5	3.8	raisin	13.3	0.81	2.8	2.8	2.0	2.3

M5 15.4



6M Canopy facing east



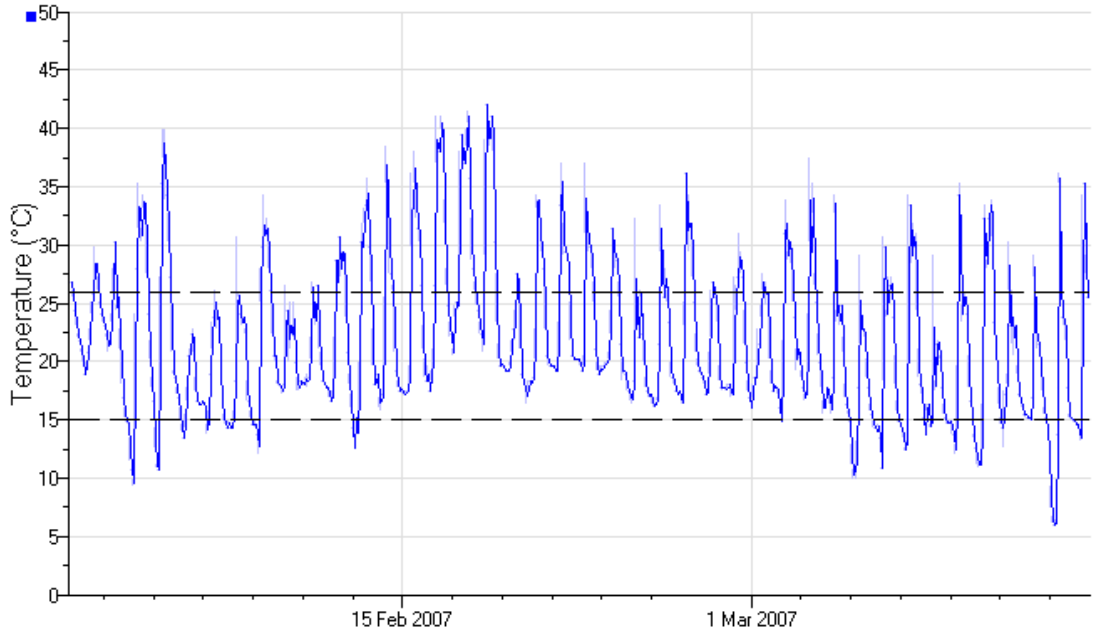
6M Bunch zone facing west



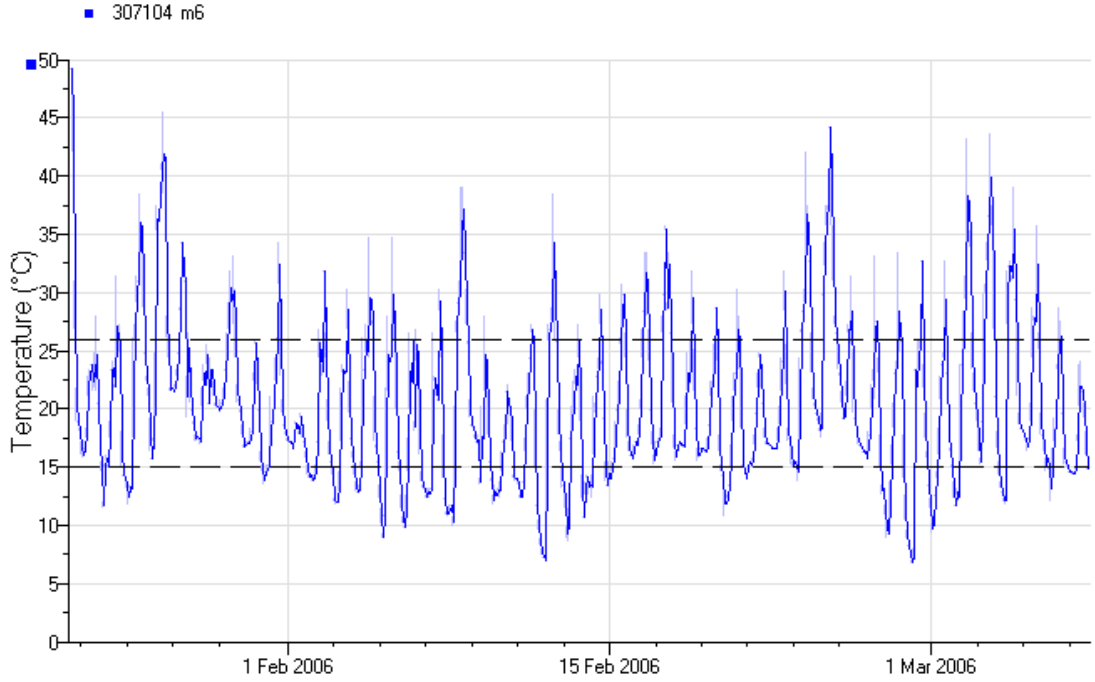
6M pre harvest



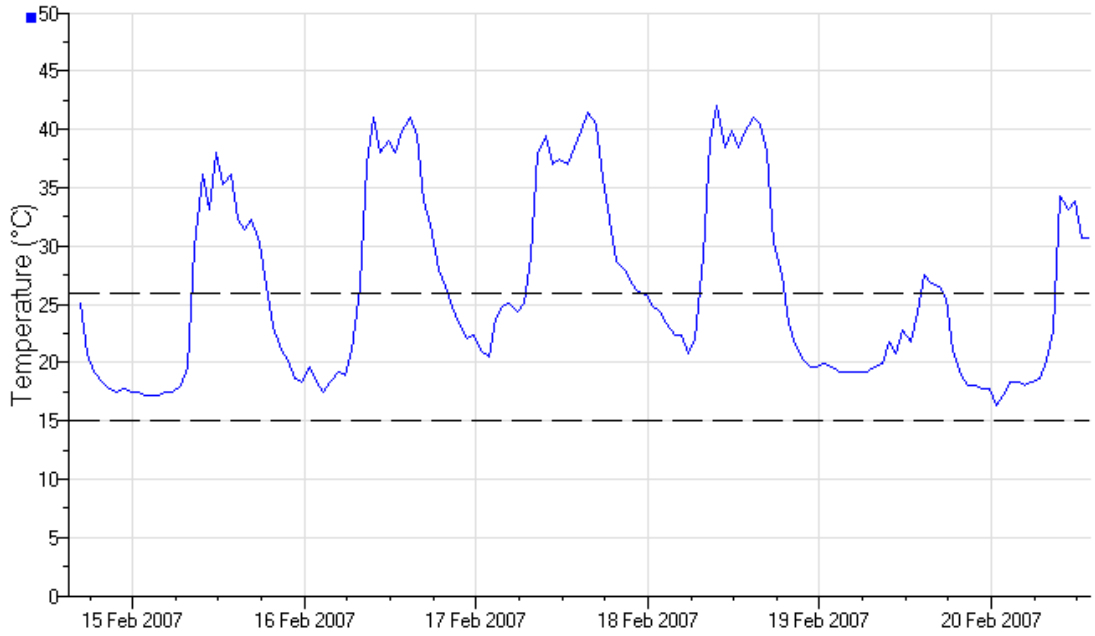
6M Bunch zone temperature ver.-har. 07



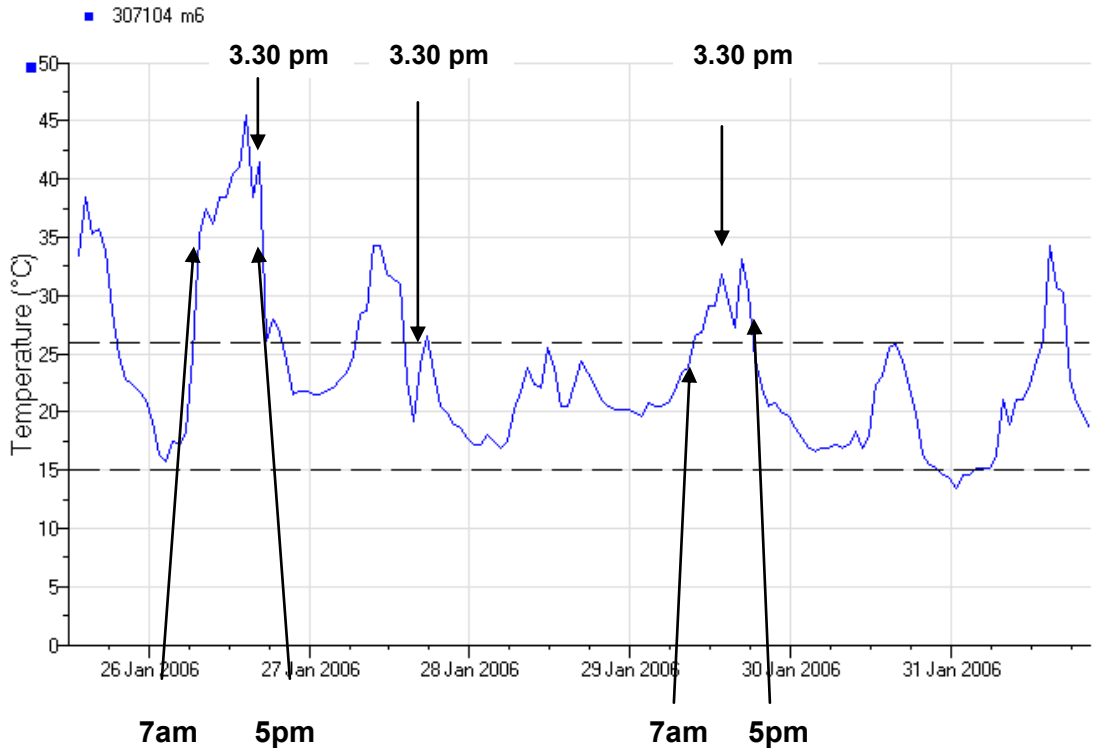
6M Bunch zone temperature ver.-har. 06 Hangtime 45d warm bunches



6M Bunch zone temperature summer 07 leafy vineyard with shade from overhead canopy



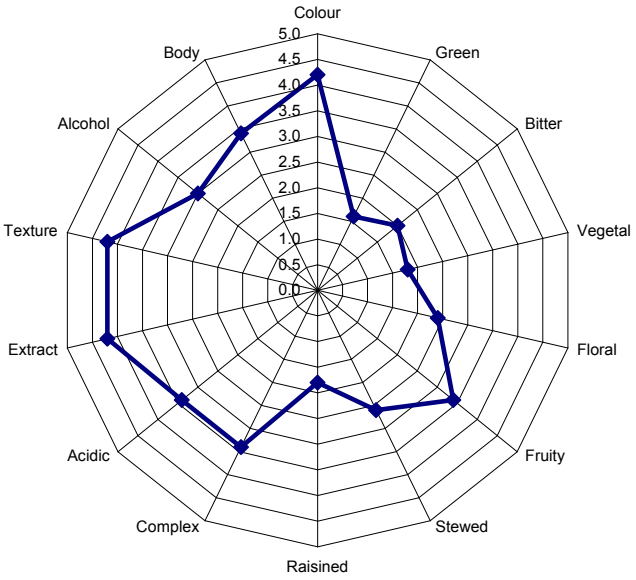
6M Bunch zone temperature summer 06 overhead foliage shade at 3.30



07: clean, consistent sample, some raisoning, well developed skins with fine tannins.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
6	41		0.88	3.7	5.4	24.6	13.7	1.10	1.19	0.34	2.8	2.8	3.0	3.0	2.8	2.8

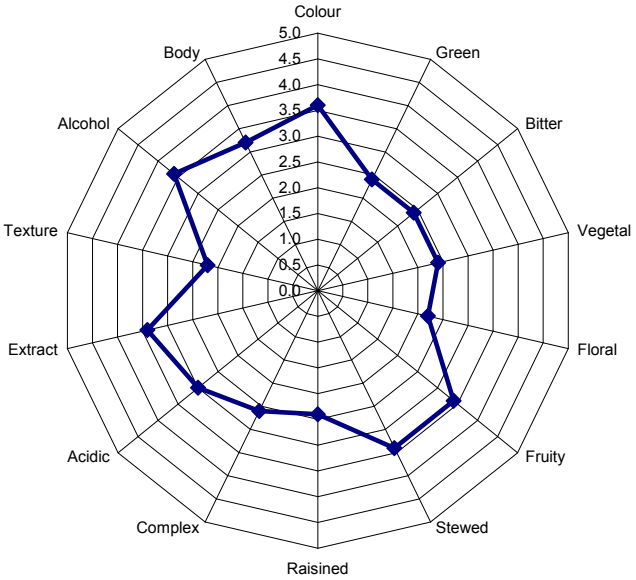
MP07 viney 6 15.8



06: Sunburn, skin grassy pulp intense

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
7.2	3.7	sunburn	13.4	0.88	3.0	3.0	2.0	2.0

m6 15.2



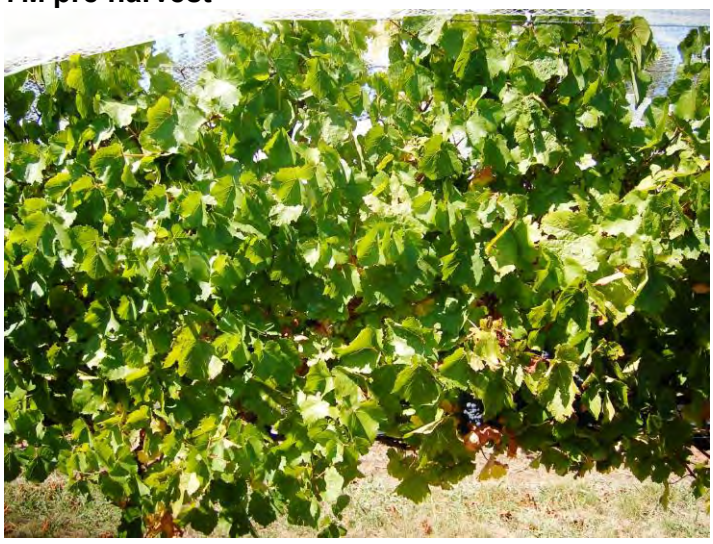
7M Canopy at veraison facing east



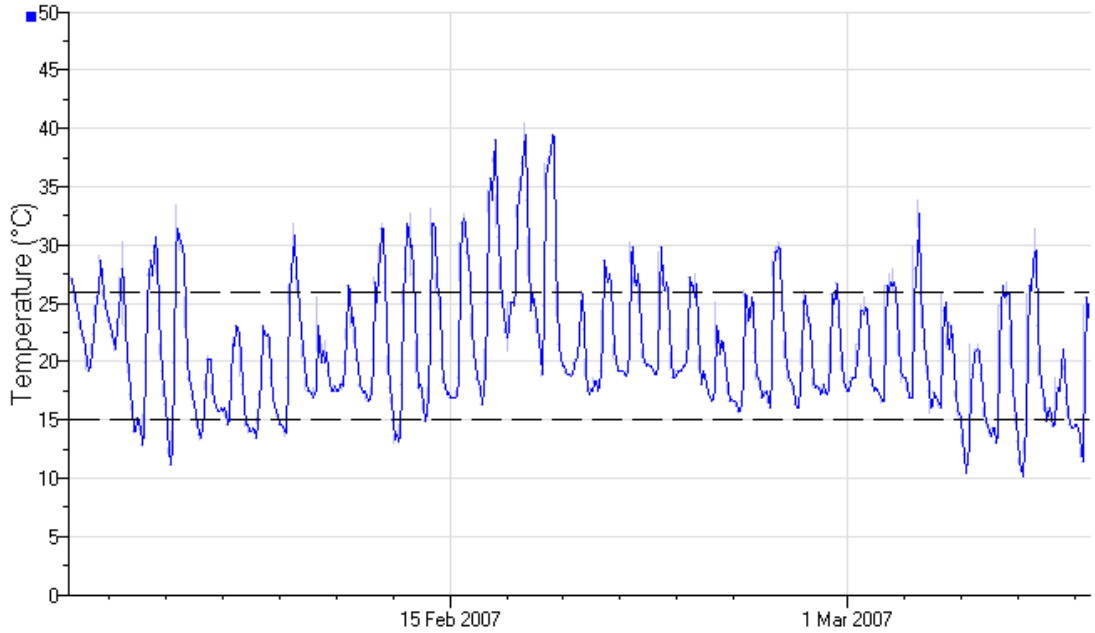
7M Bunchzone facing west



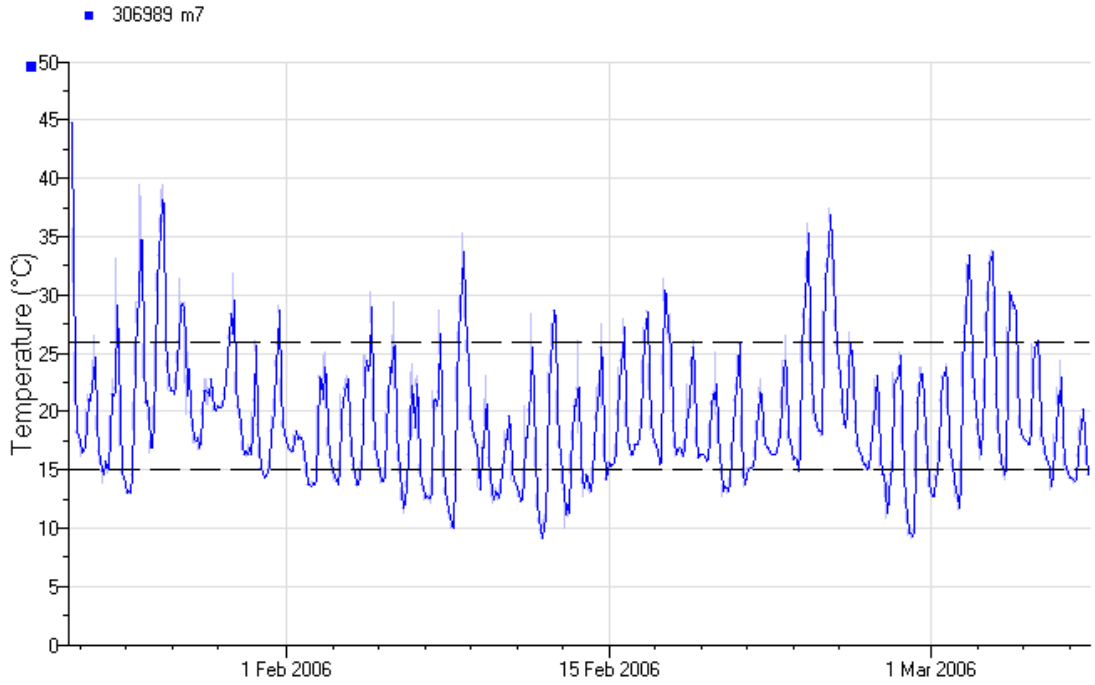
7M pre harvest



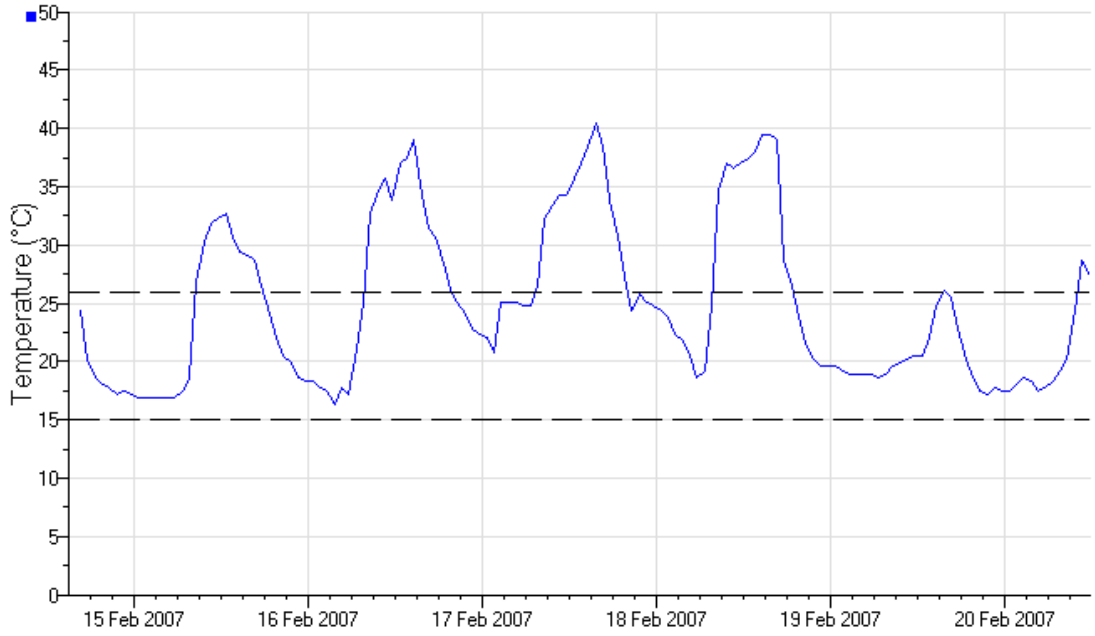
7M Cool bunchzones 07



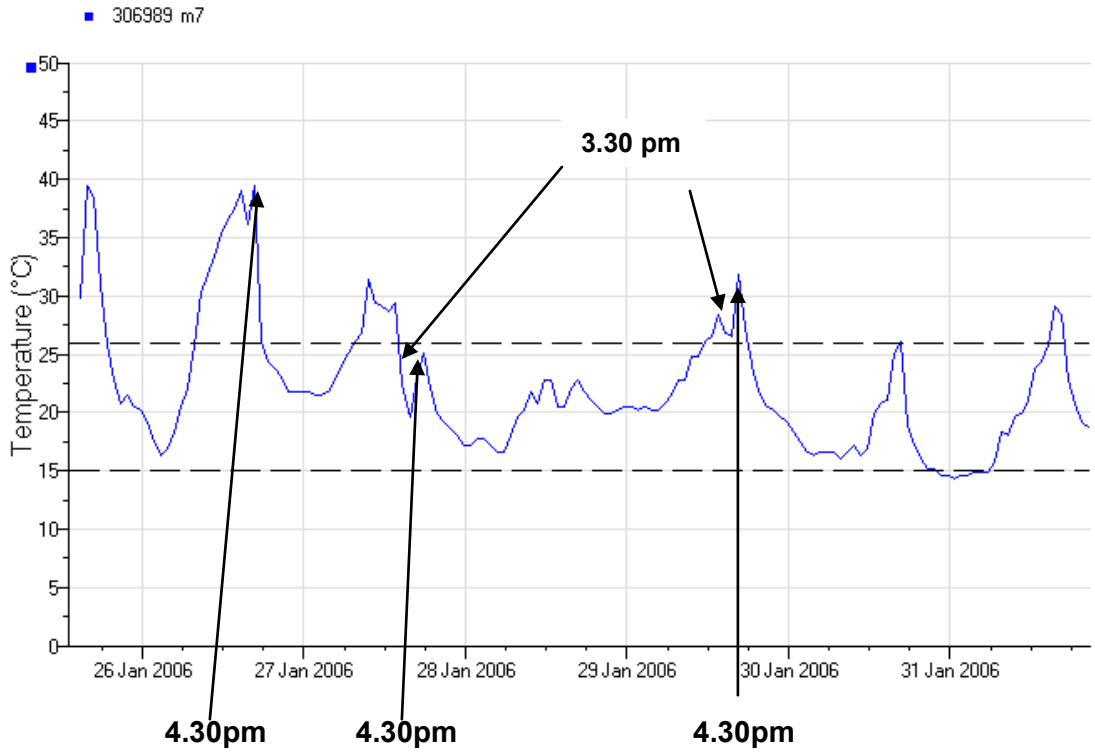
7M Cool bunchzones 06.



7M Bunchzone temperatures during a hot spell 07 good canopy protection.



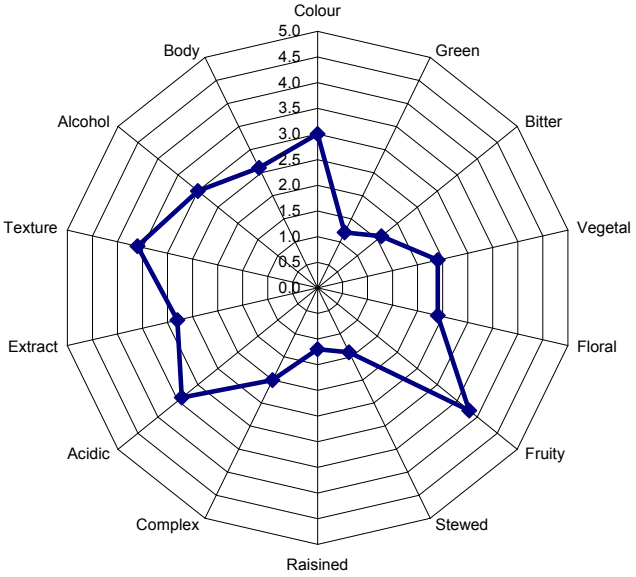
7M Canopy temperatures 06, overhead shade at 3.30, leaf cover east 1.2 and west 1.3 layers



07: small berries, 2 with LBAM, fresh fruity flavour, grassy skins, many undeveloped seeds.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
7	35		0.84	3.7	6.9	23.2	12.9	1.11	1.13	0.34	3.0	2.5	3.0	3.0	2.0	2.3

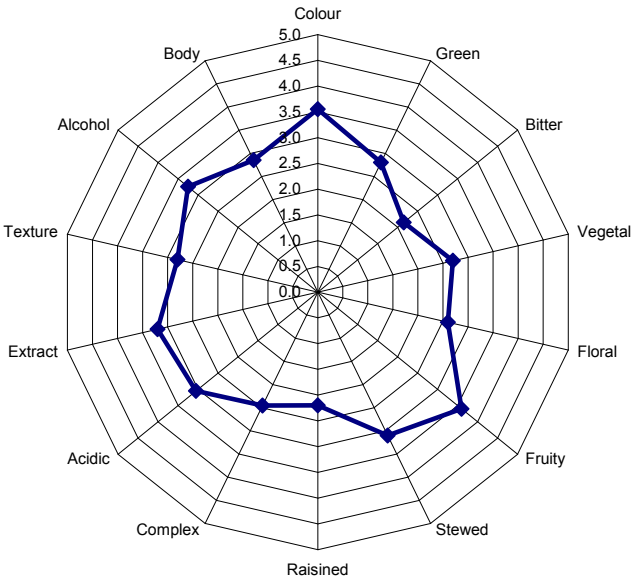
MP07 viney 7 - 16.5



06: Pulp fresh intense skin grassy no sunburn

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
6.9	3.6		13.0	0.90	3.0	3.3	2.3	2.0

m7 15.5



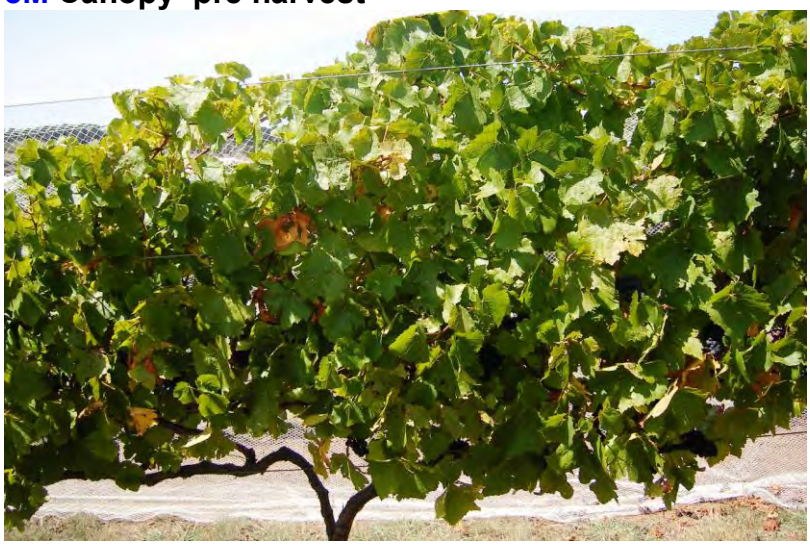
8M Canopy facing east



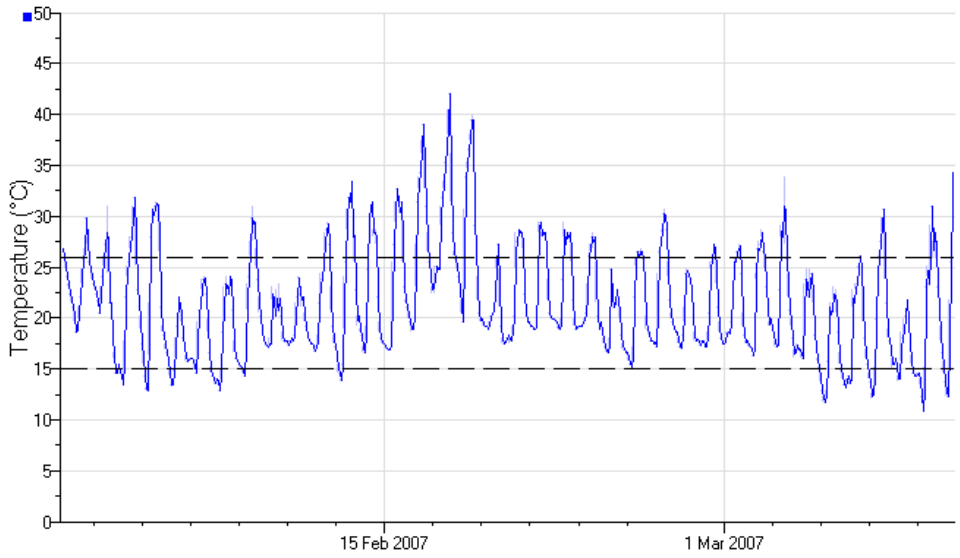
8M Canopy facing west



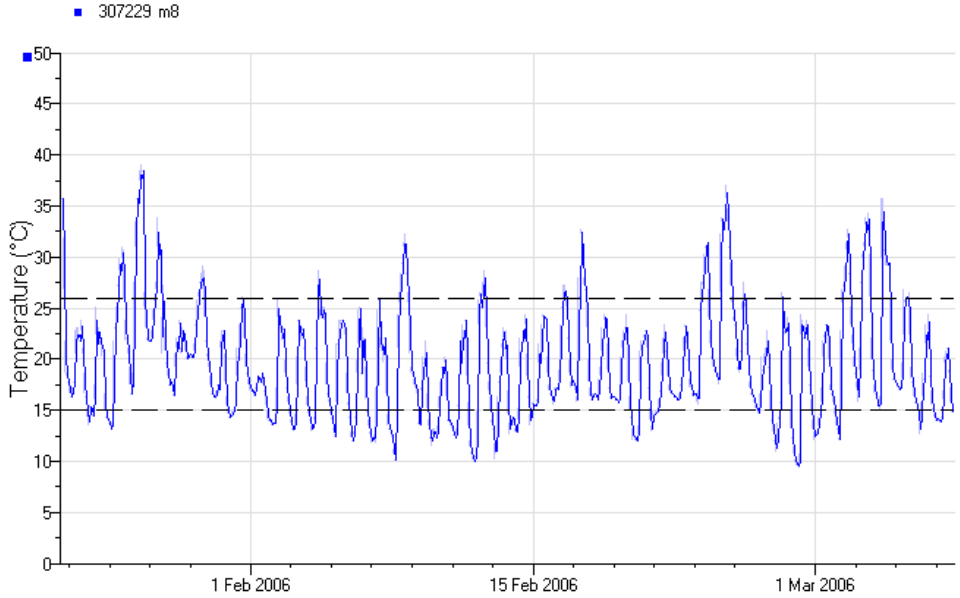
8M Canopy pre harvest



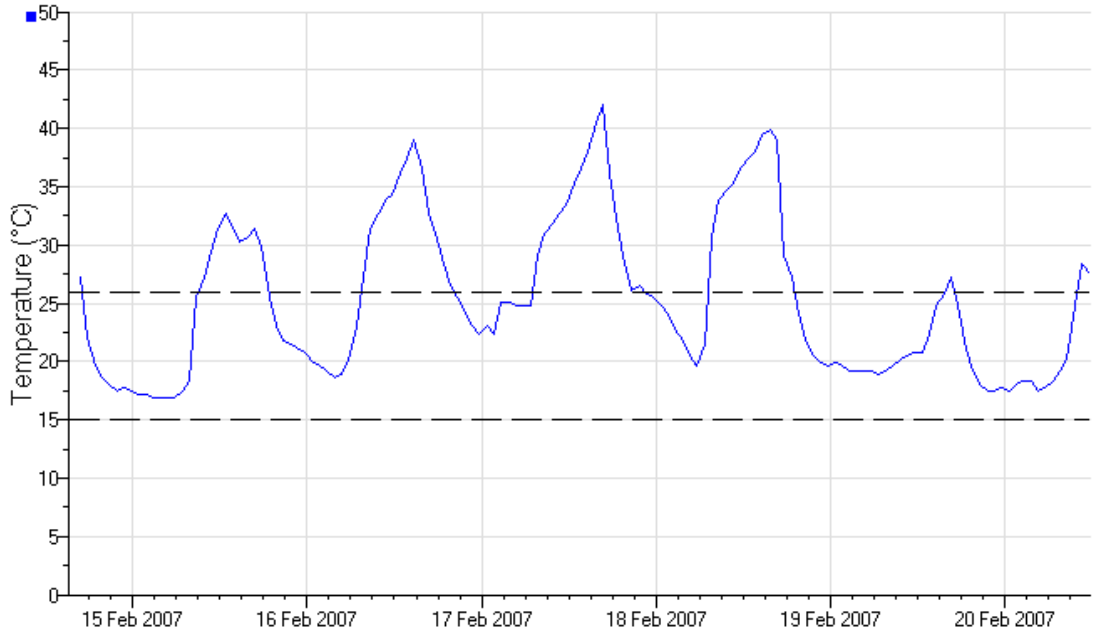
8M Temperatures dataloggger 8 in 07



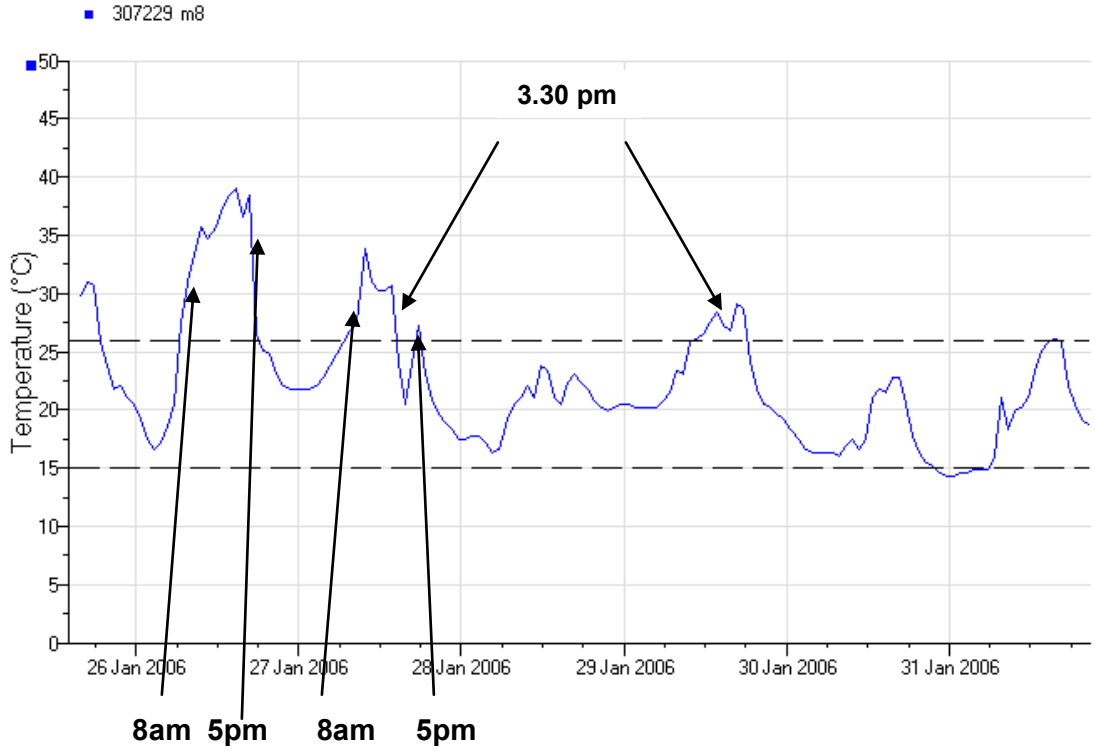
8M Temperatures dataloggger in 06



8M Temperatures in a hot week dataloggger 8 in 07



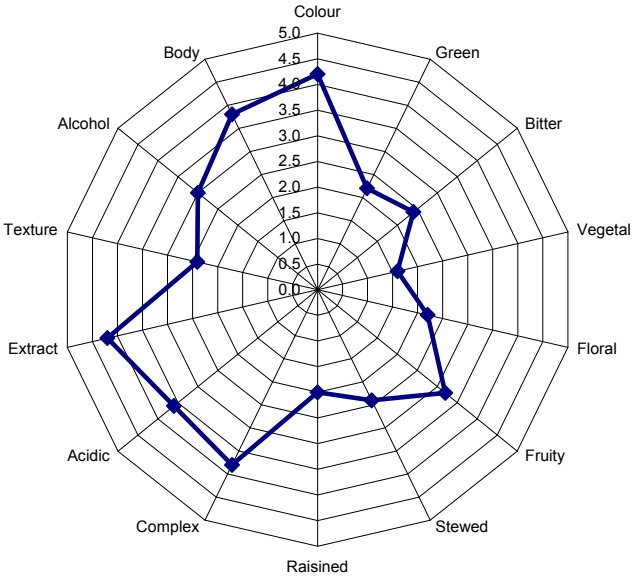
8M Morning shade and on warm days afternoon sun 4-5pm in 06



O7: clean sample, sugar/acid balanced with intense plum aroma, slightly green skins.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
8	35		0.63	3.6	6.6	23.9	13.3	1.41	1.23	0.38	2.8	2.0	3.0	3.0	2.0	2.3

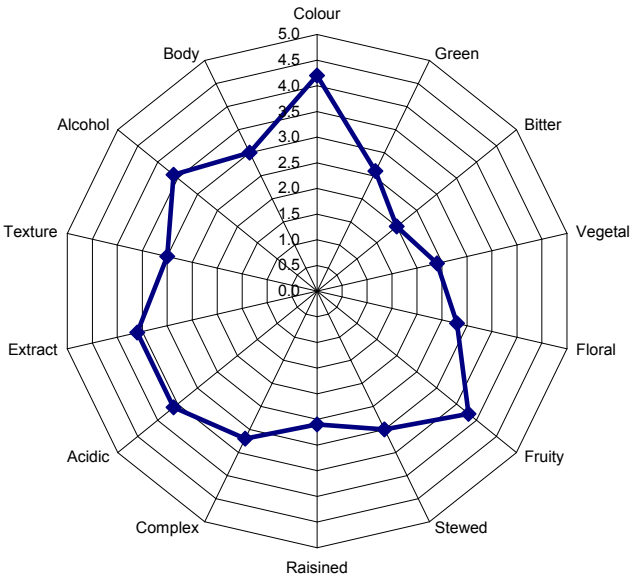
MP07 viney 8 16.7



06:Fresh rich pulp and bitter green sappy skins

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
8.7	3.8	sh	13.3	0.86	2.2	2.2	2.2	2.3

M8 16.9



9M Row facing east



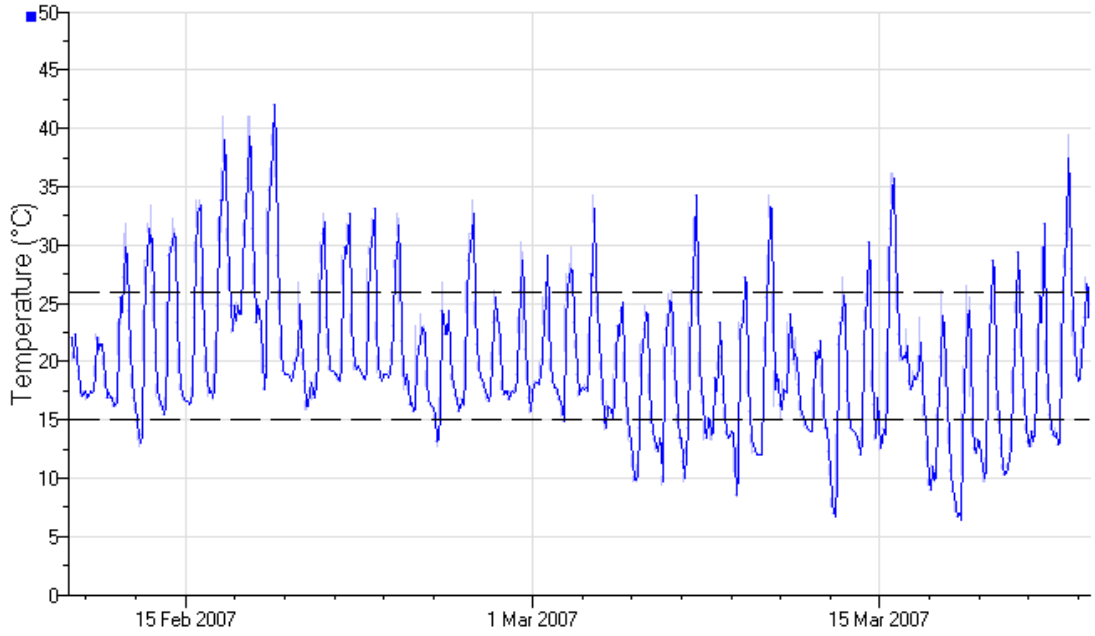
9M Canopy facing west



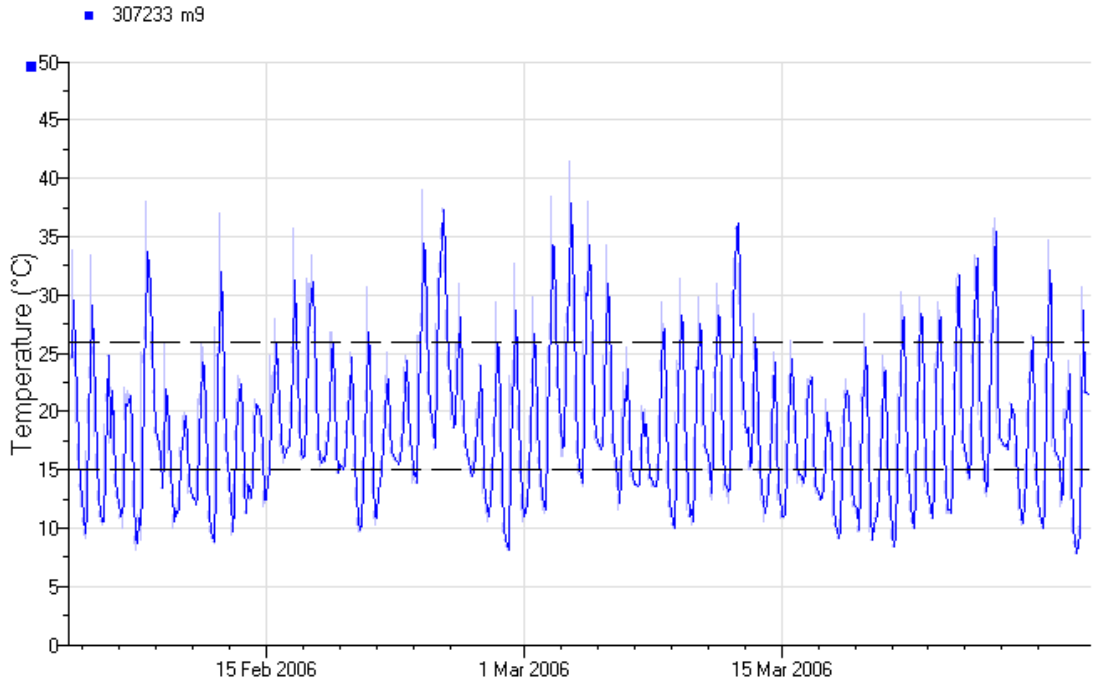
9M Canopy Pre harvest



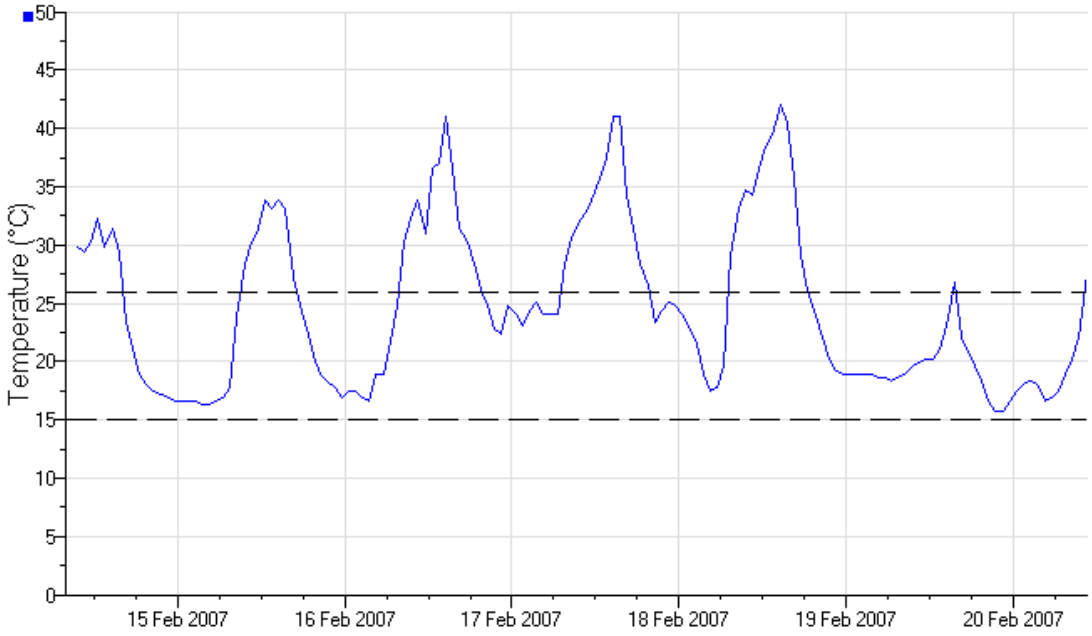
9M Temperatures in 07



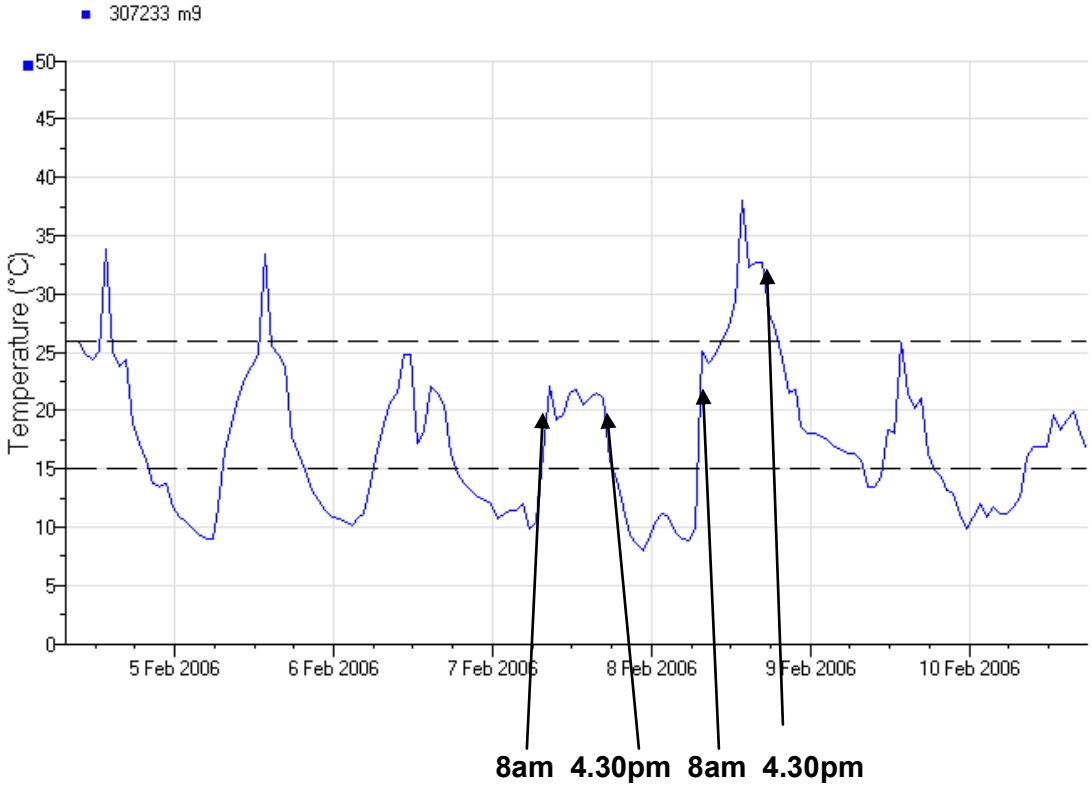
9M Temperatures in 06



9M Temperatures in a hot week 07



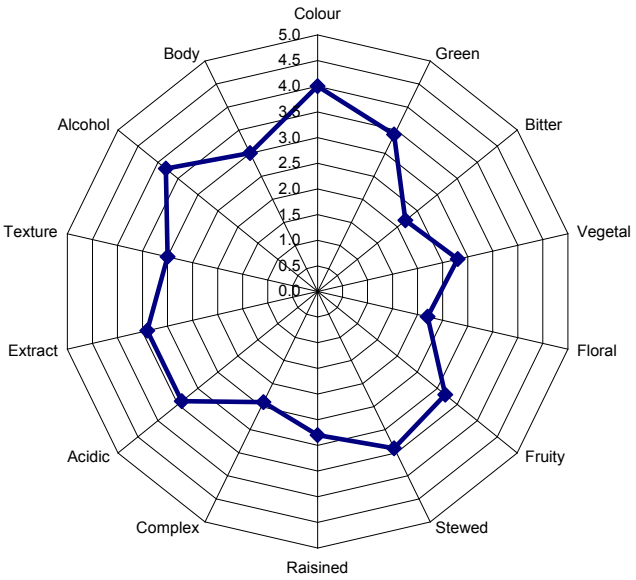
9M Temperatures in a hot week 06



07: clean sample, tiny bunches, fresh flavours, some raison, grassy skins.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
9	42		0.63	3.8	6.9	24.0	13.3	0.99	1.19	0.37	2.8	2.2	3.0	3.0	2.5	2.0

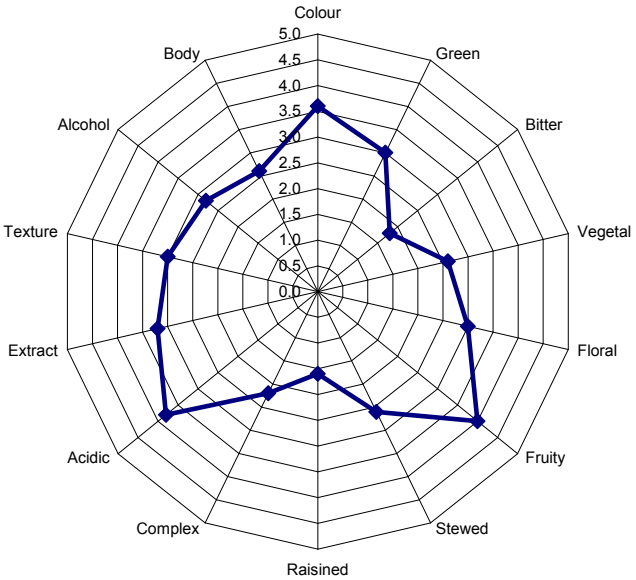
MP07 viney 9 - 15.8



06: Plummy sweet pulp and grassy skin

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
5.9	3.8		13.9	1.03	3.0	3.0	2.3	2.2

m9 15.2



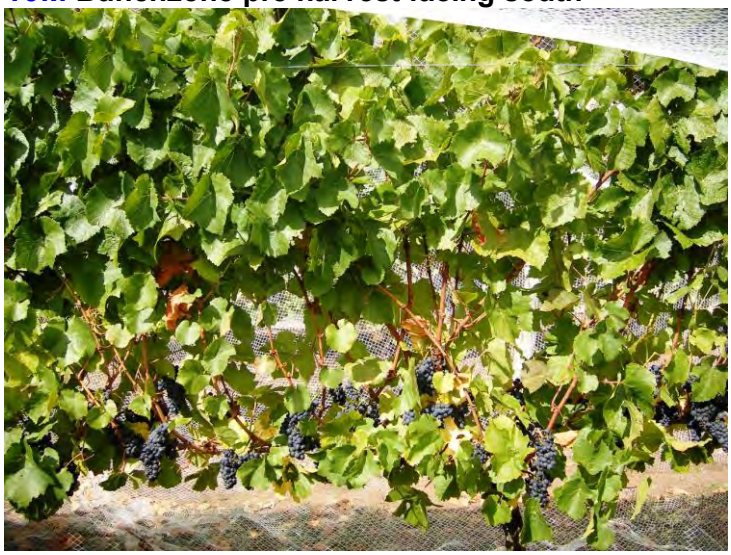
10M Elevated, E/W rows, canopy at veraison facing south



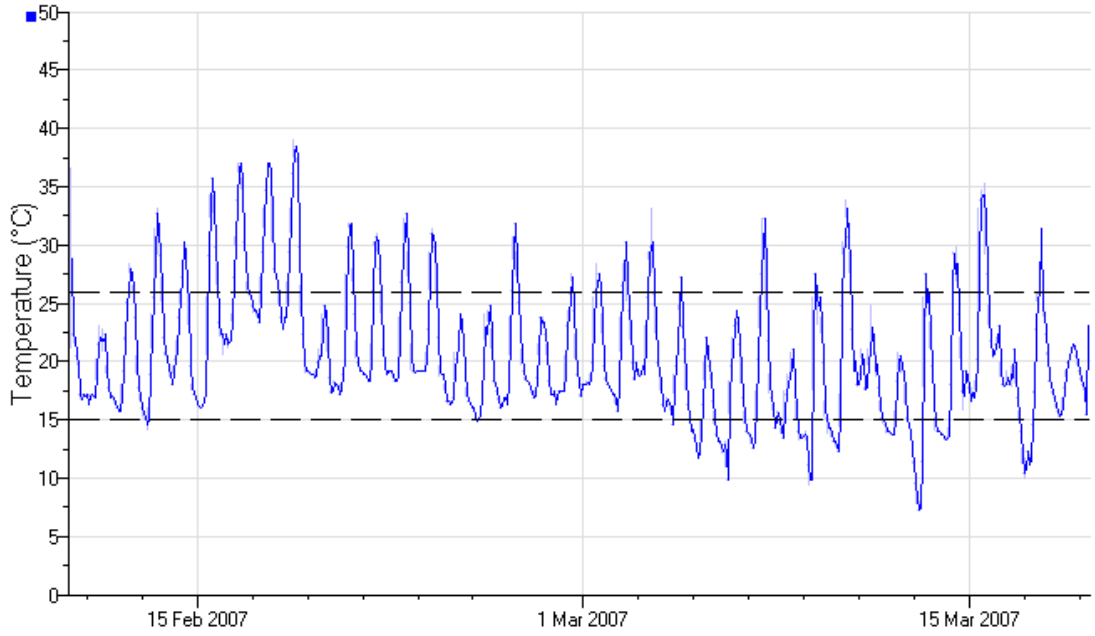
10M Bunchzone facing north



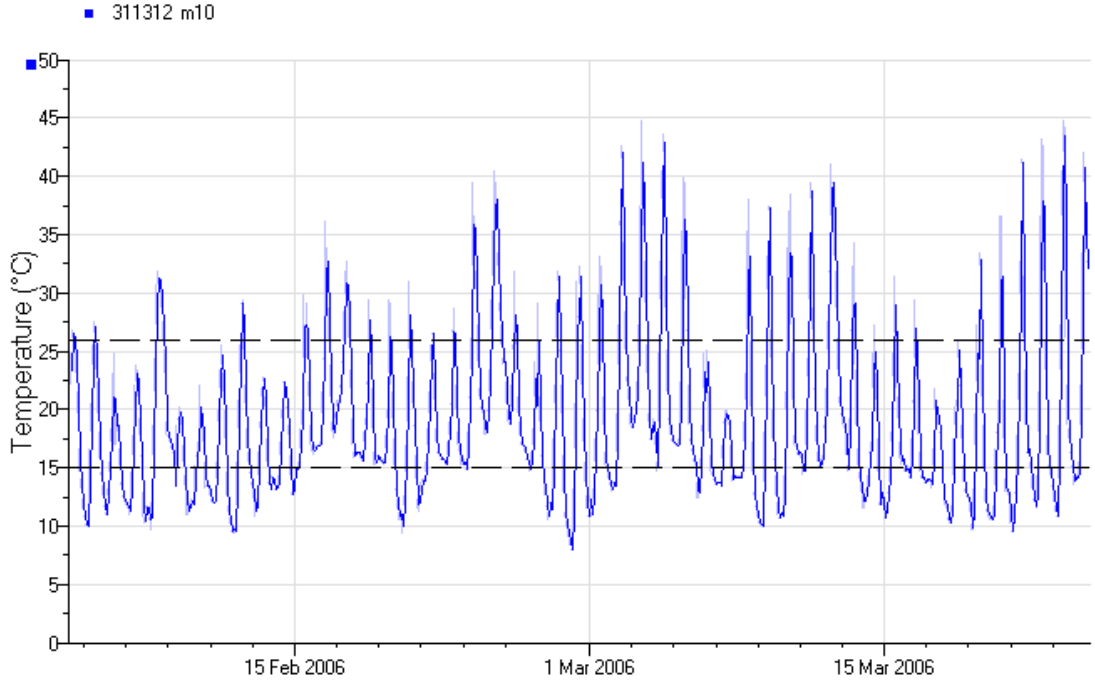
10M Bunchzone pre harvest facing south



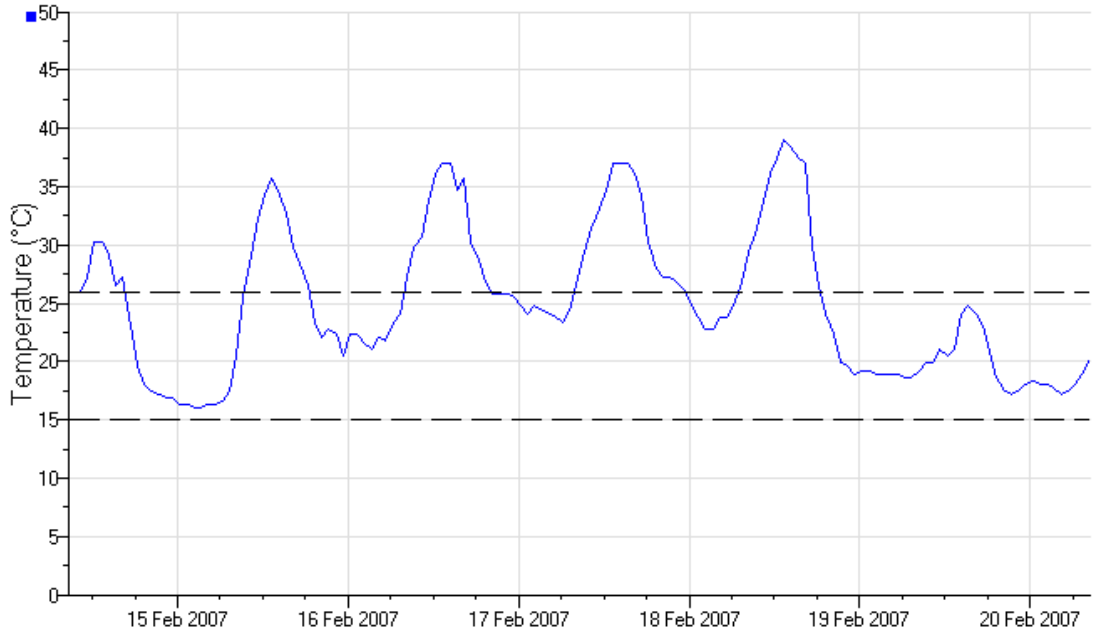
10M Bunchzone temperatures in 07



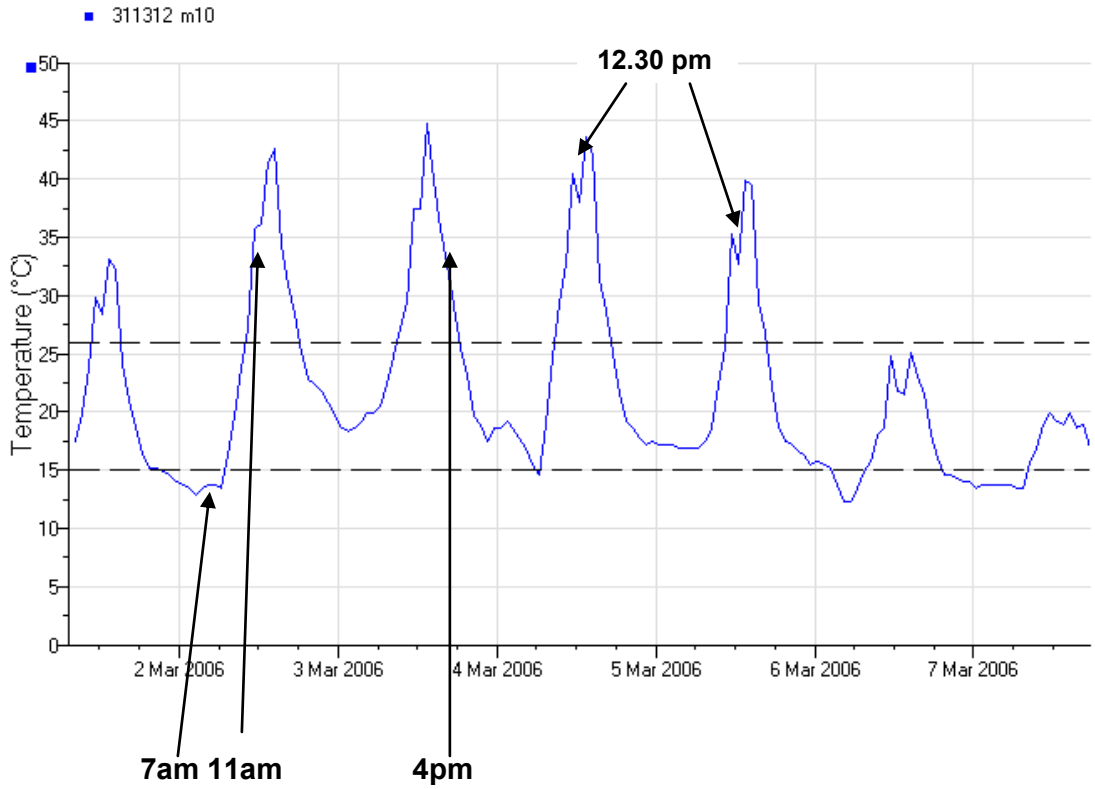
10M Bunchzone temperatures in 06



10M Temperatures in a hot week in 07



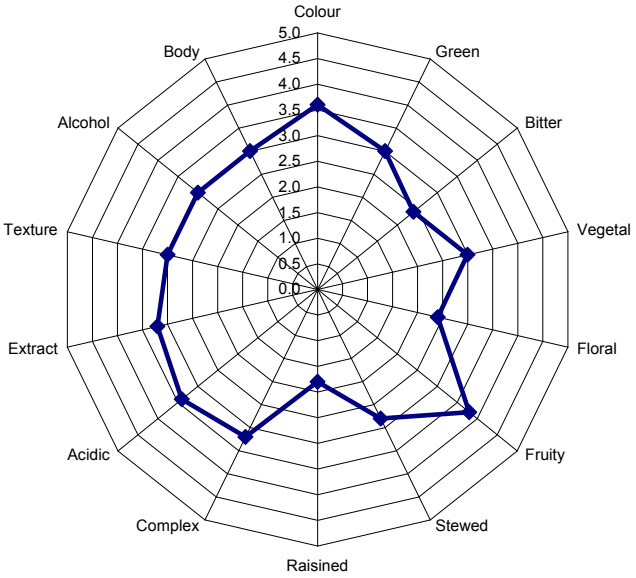
10M Temperatures in a hot week in 06



07: clean sample, small bunches with fresh flavour, consistent.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
10	36		0.66	3.7	6.1	23.6	13.1	0.82	0.95	0.30	2.2	2.7	3.0	3.0	2.3	2.0

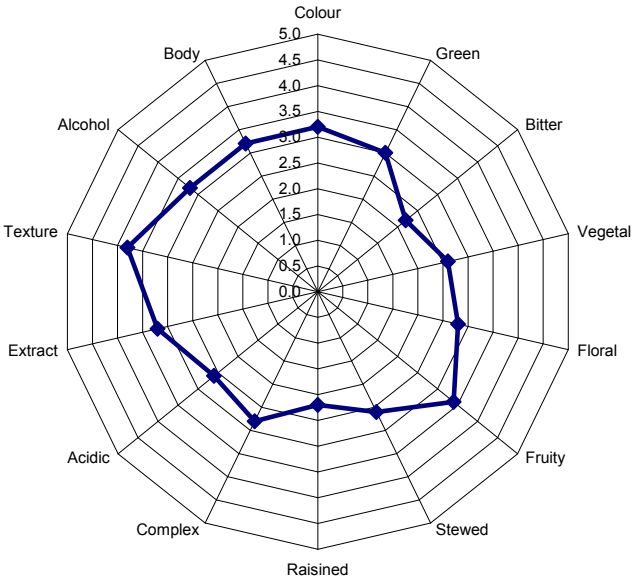
MP07 viney 10 16.0



06: Plum and jam pulp and fruity skins no shrivel - large berries well watered?

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
6.1	3.8		13.2	0.96	3.3	3.6	2.6	2.0

m10 14.8



11M Canopy at veraison facing east



11M Canopy facing west

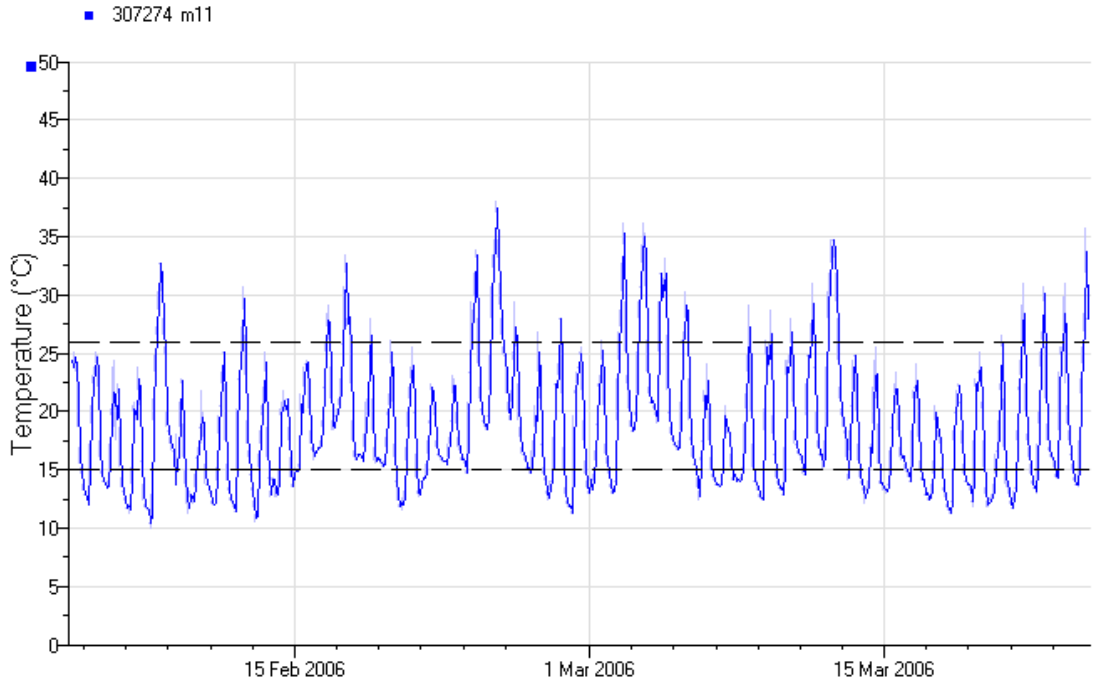


11M pre harvest

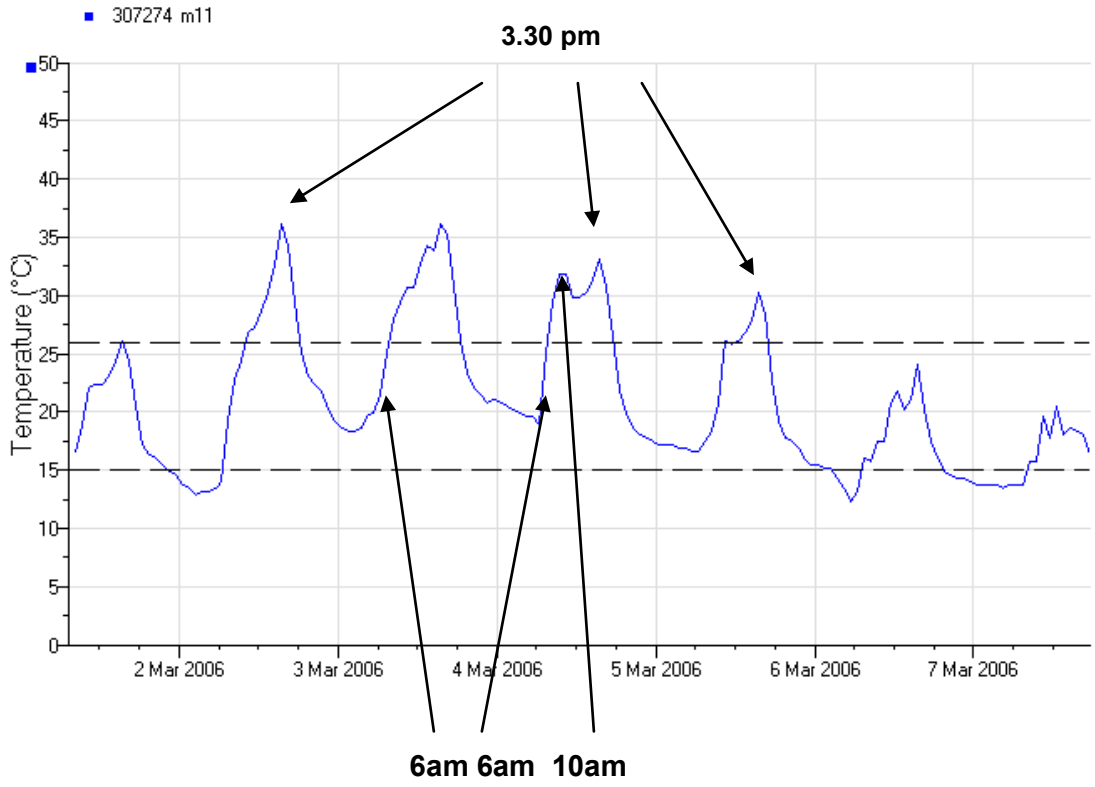


no dataloggger in 07

11M in 06



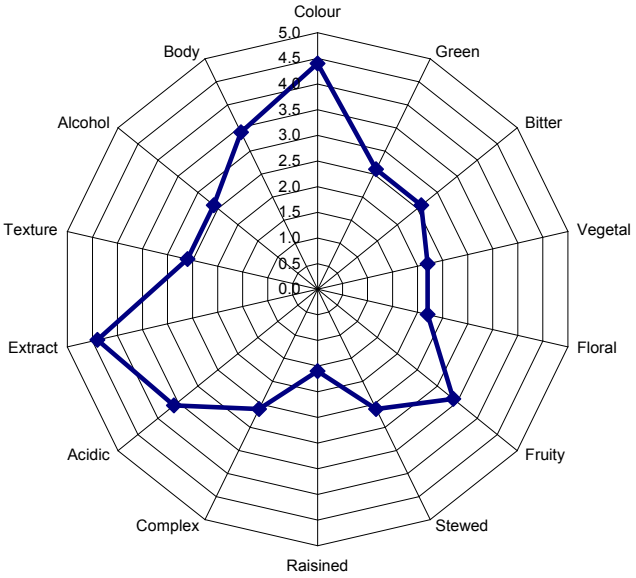
11M Slow morning warm-up on cool days



07: clean sample, small bunches with varied berry size, ripe plum flavour, some showing tough/green skin tannin.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
11	42		0.65	3.7	6.5	24.4	13.6	1.14	1.50	0.46	3.0	2.3	3.0	3.0	2.0	2.0

MP07 viney 11 - 16.1



06: Low acid (water stress) pulp gelatinous (water stress symptoms) with plum and quince aromas and grassy skin. No wine.

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
5.7	3.7	su	13.3	0.91	3.0	3.8	2.3	3.0

No wine

M12 Canopy at veraison facing east



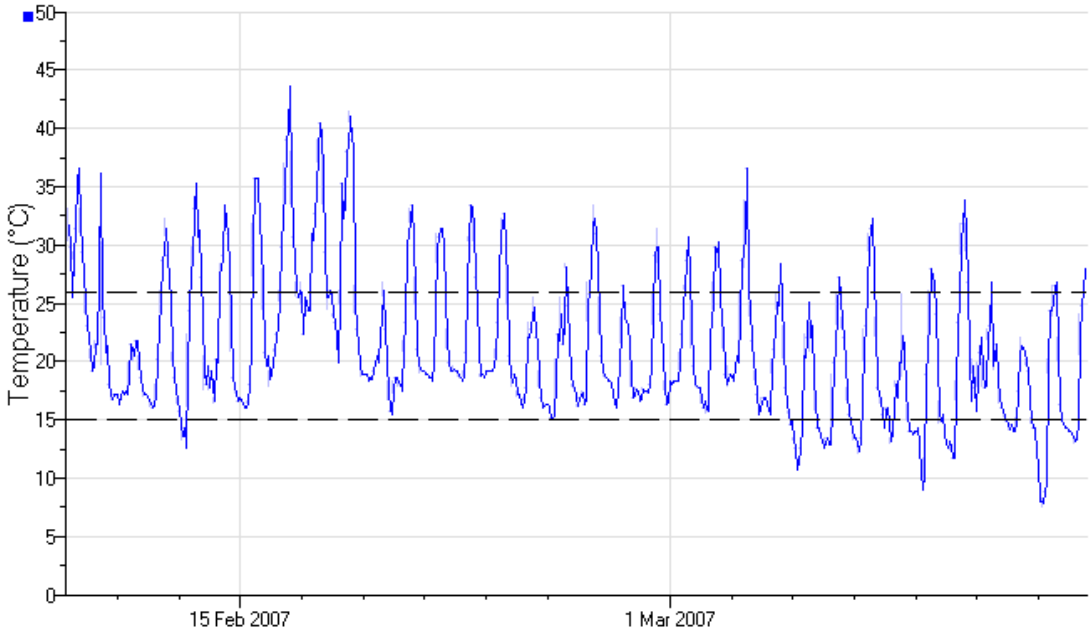
M12 Canopy west



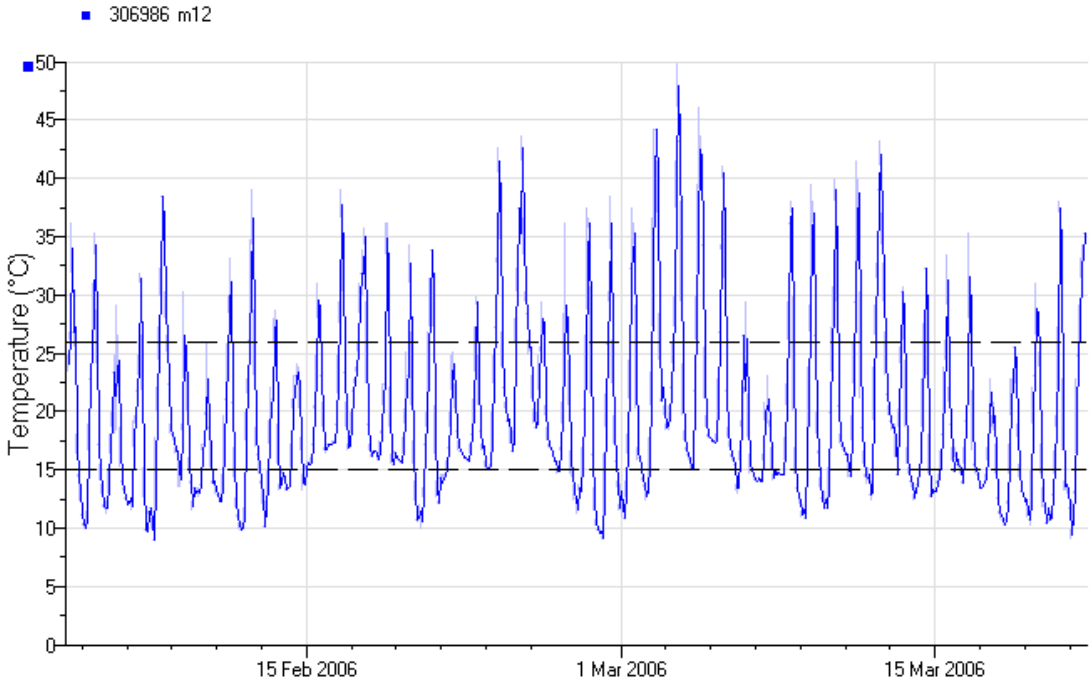


M12 pre harvest

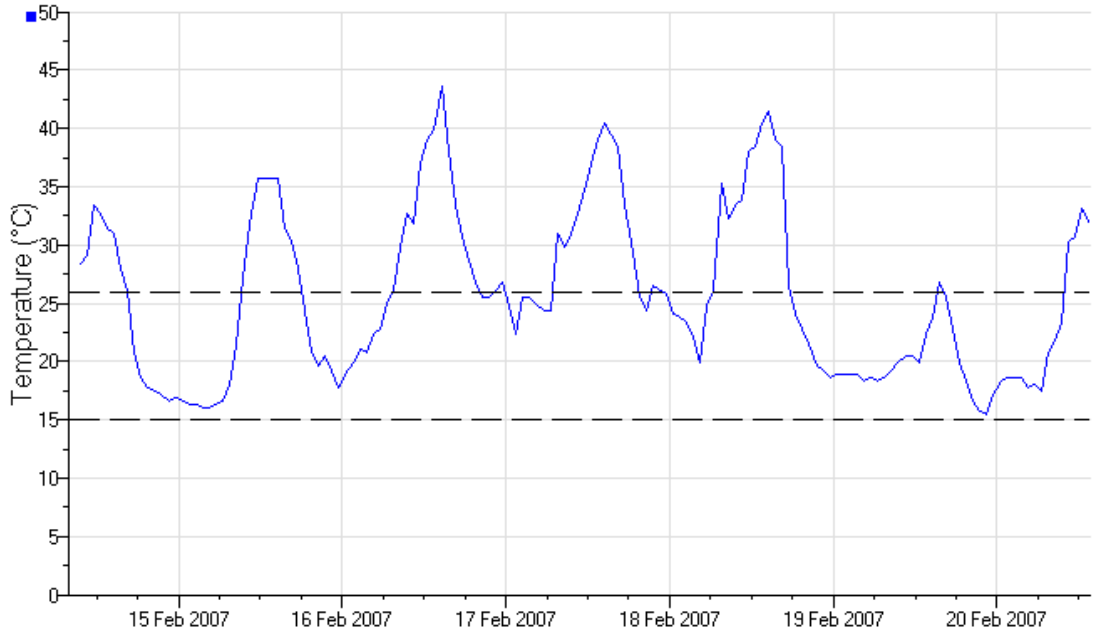
M12 Bunchzone temperatures 07



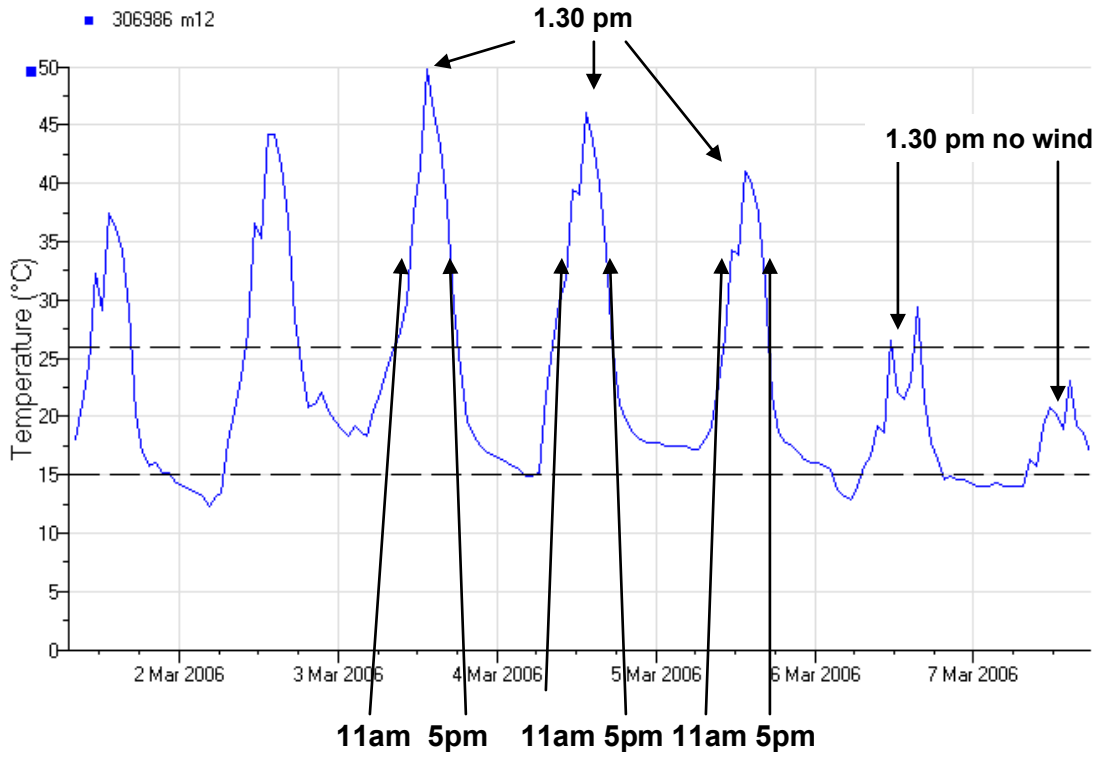
M12 Warmer bunchzones in 06



M12 A hot week in 07



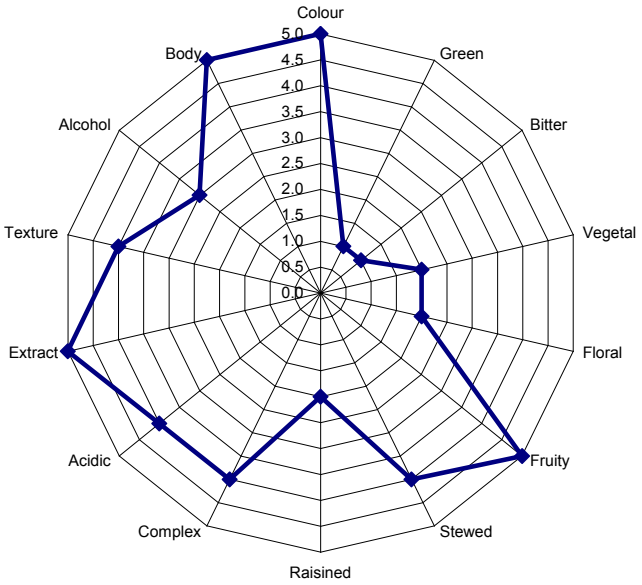
M12 A hot week in 06



07: clean, small bunches, no bloom and some juicing, low acid/sugar, smoky/woody taste, some raisons, unusual.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
12	34		0.75	3.7	5.4	22.7	12.6	1.09	0.85	0.31	2.8	2.3	2.5	2.2	2.2	2.2

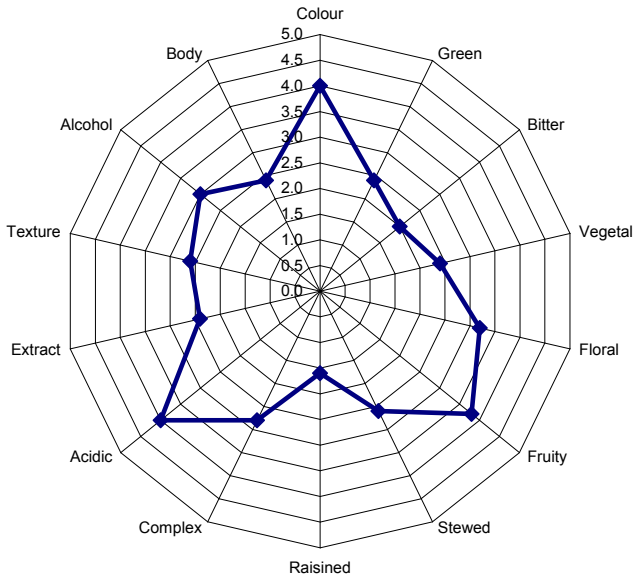
av12



06:Well watered. Large berries with good acid, fresh intense ripe pulp, ripest skins

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
7.0	3.6		13.1	1.08	4.0	3.0	3.3	2.2

M12 score 16.2



M13 Canopy at veraison facing east



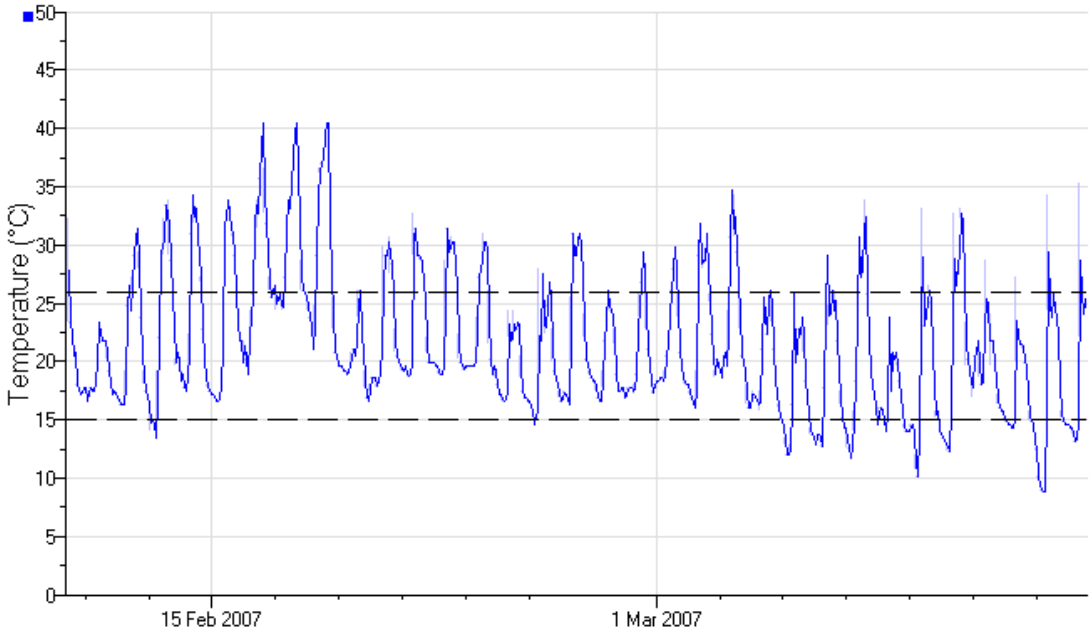
M13 Canopy facing west



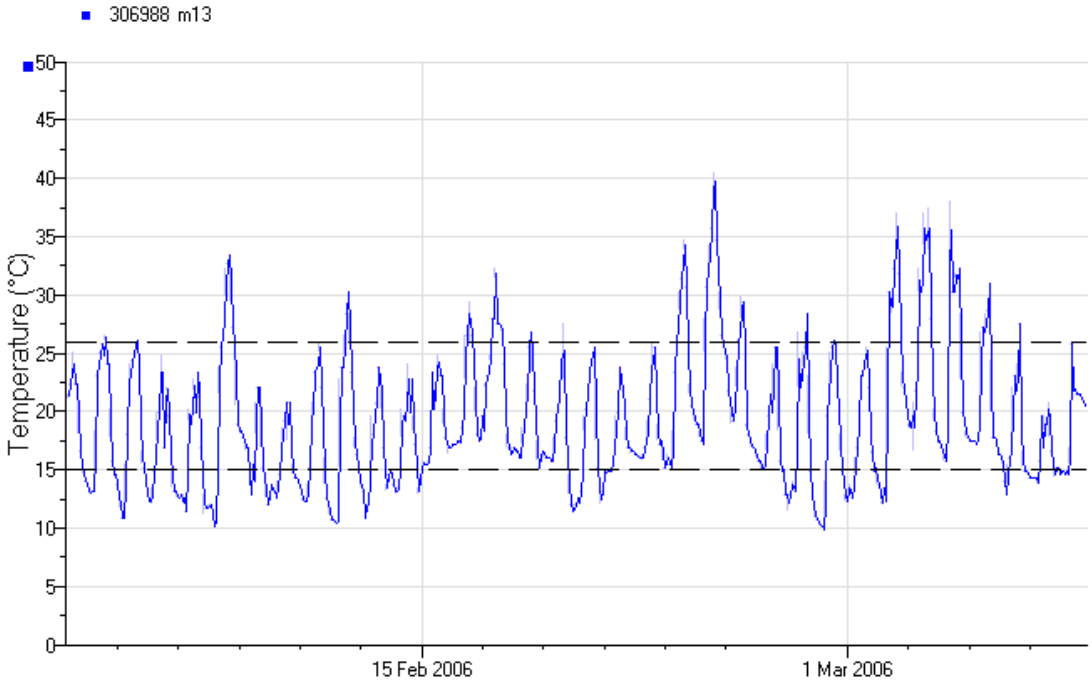


At harvest

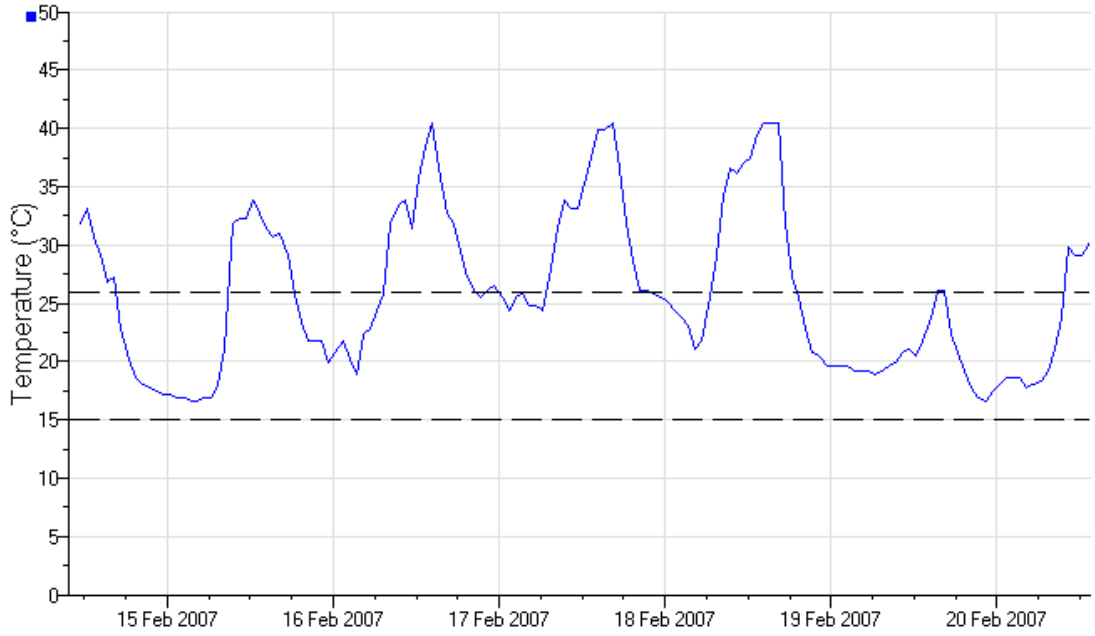
M13 Bunchzone temperatures in 07



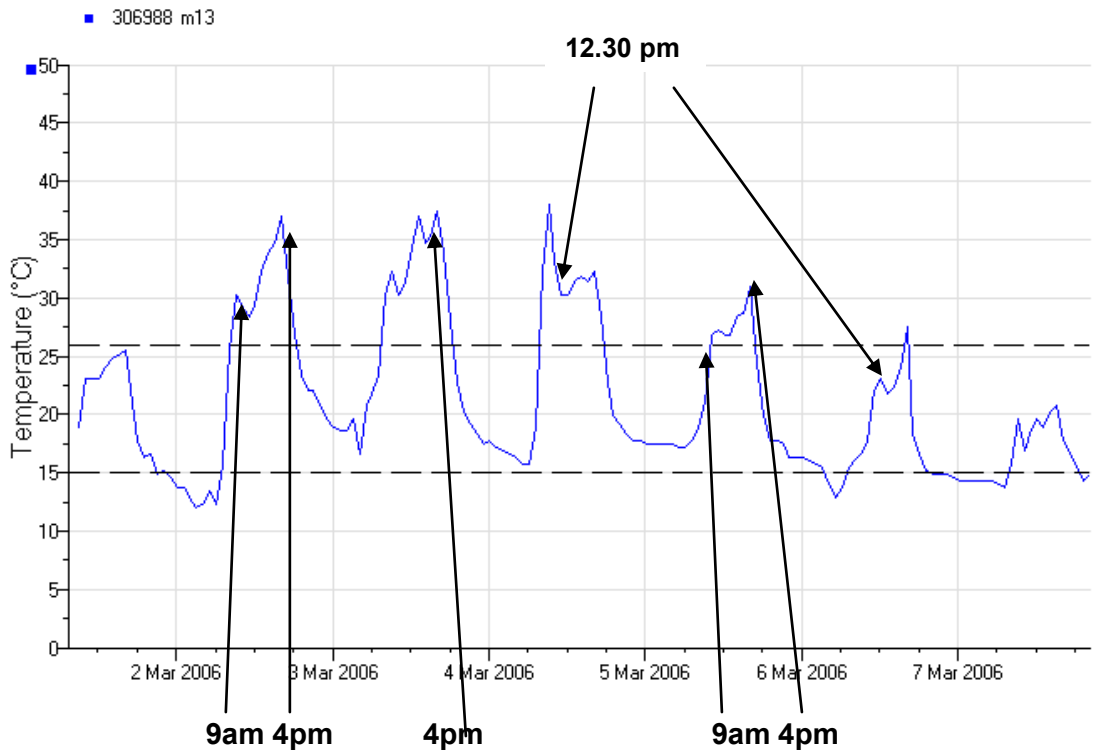
M13 Bunchzone temperatures in 06



M13 In a hot week 07

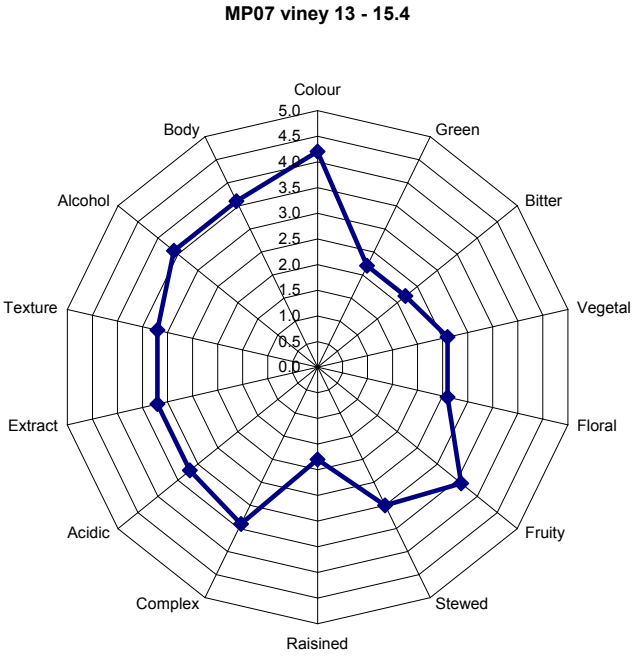


M13 In 06 with a rolling canopy



07: clean sample, small bunches, some juicing, ripe dark cherry flavour, low acid with high woody tannin in skins.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
13	38		0.80	3.7	5.4	23.5	13.1	1.25	1.07	0.34	2.7	2.3	3.0	3.0	2.5	2.5



06: Pulp dry not ripe, skin not ripe. No wine.

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
11.7	3.8	sh	13.8	0.53	2.2	2.2	2.2	2.0

M15 Canopy at veraison facing east



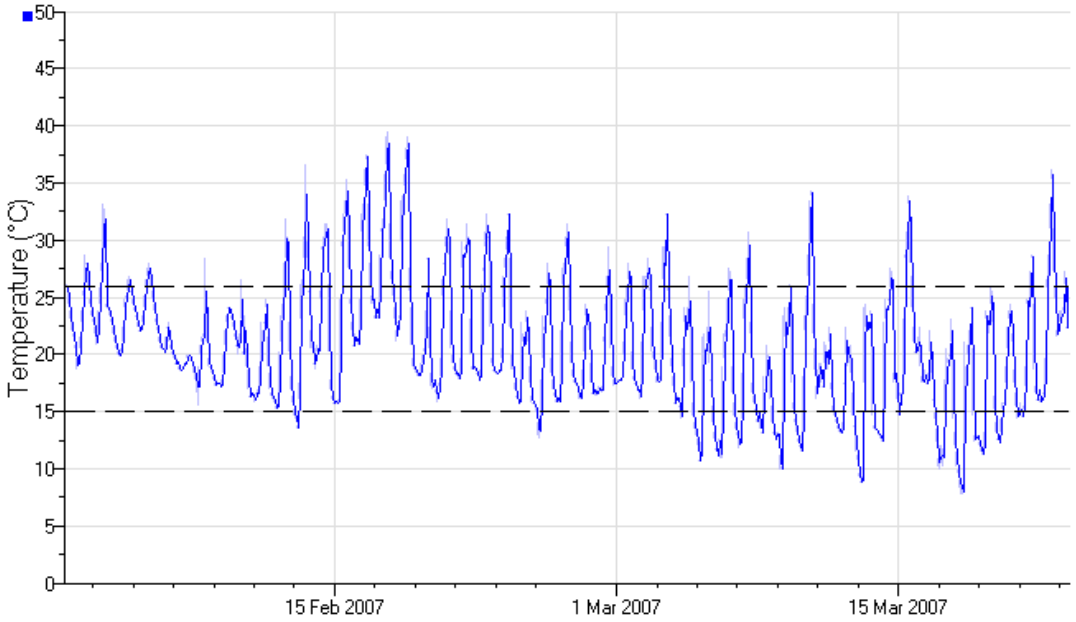
M15 Canopy facing west



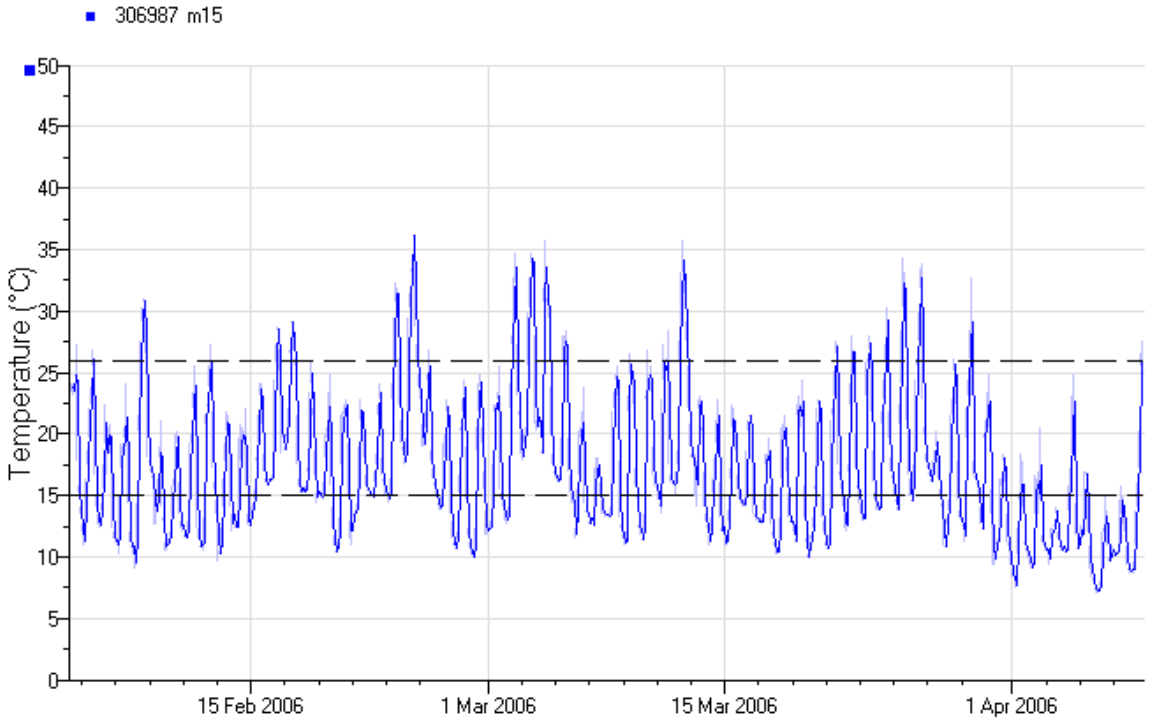
M15 at harvest 07



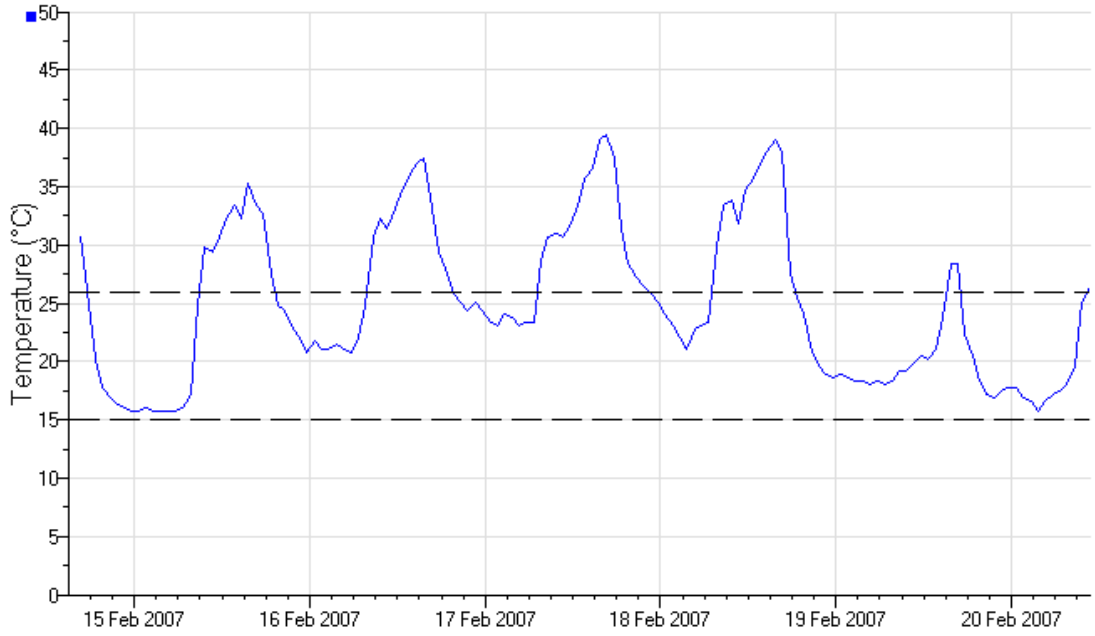
M15 a In 07 = 503 av. deg. h



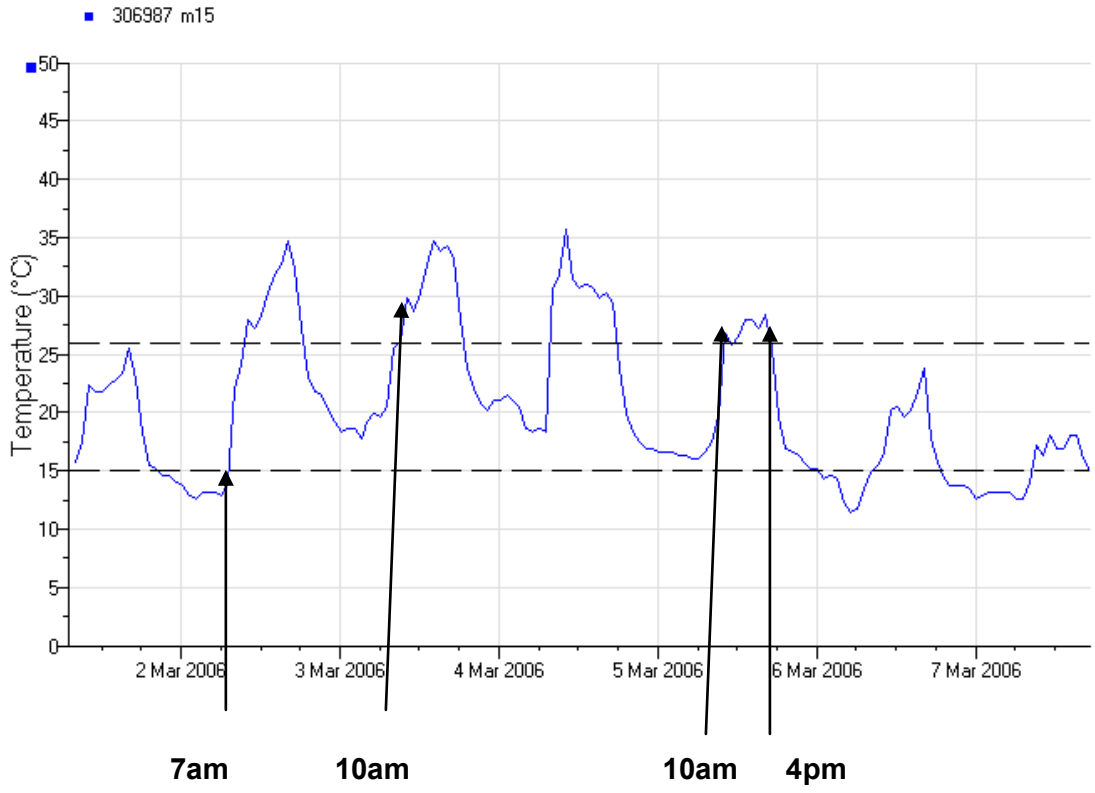
M15 in 06 =418 av. deg. h



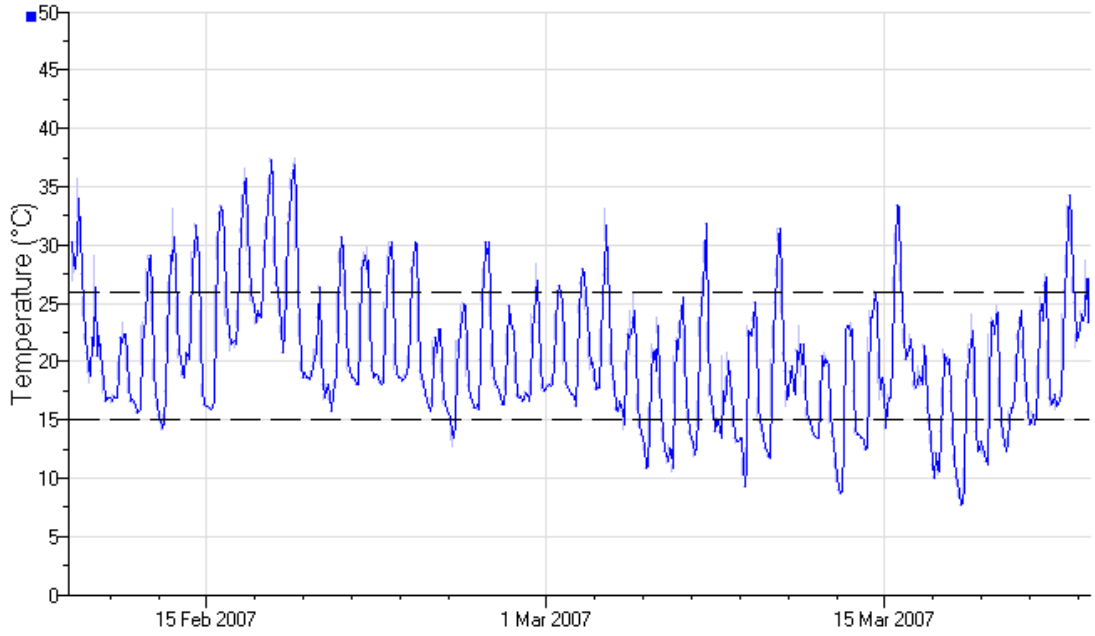
M15 In a hot week 07



M15 in a hot week 06



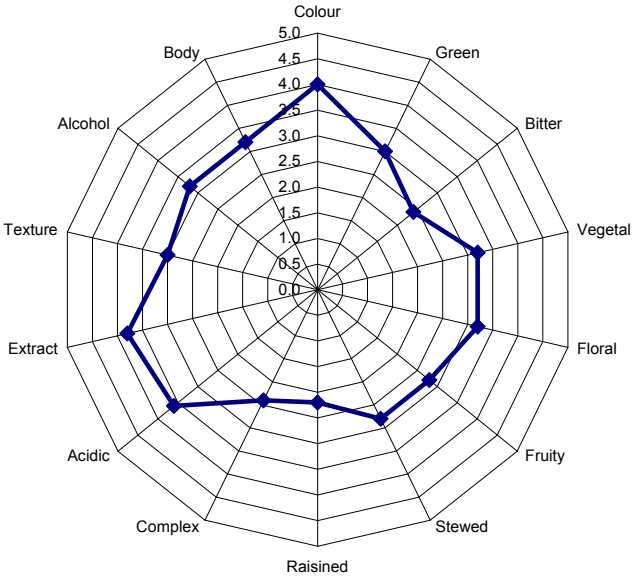
M15b In 07 20,479 cumulative degree h in 42d = 488 av. deg h



07: clean sample, large berries in perfect condition with plum/anise flavours, skins green/grassy, minimal shrivel.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
15	42		0.78	3.7	6.8	23.4	13.0	1.13	1.43	0.43	2.2	2.3	2.7	2.7	1.7	2.0

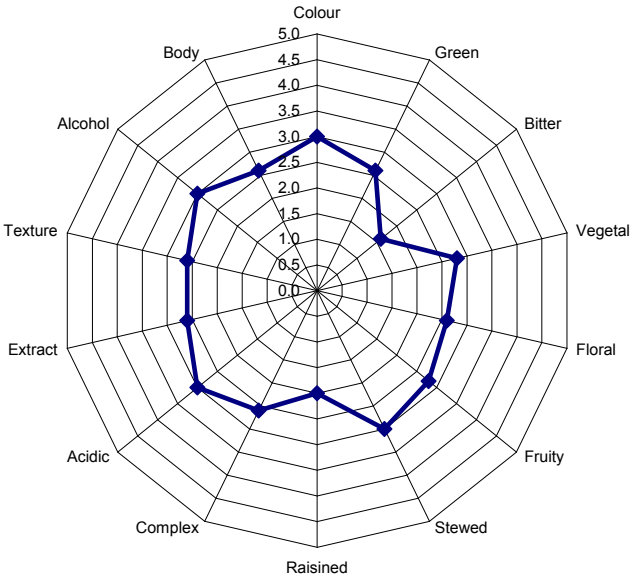
MP07 viney 15 -14.5



06: Rich quince plum jam pulp, fine skin tannins, ripest seeds

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
6.0	3.7		14.0	0.98	3.8	3.6	2.5	2.7

m15 15.1



M16, canopy at veraison, facing south



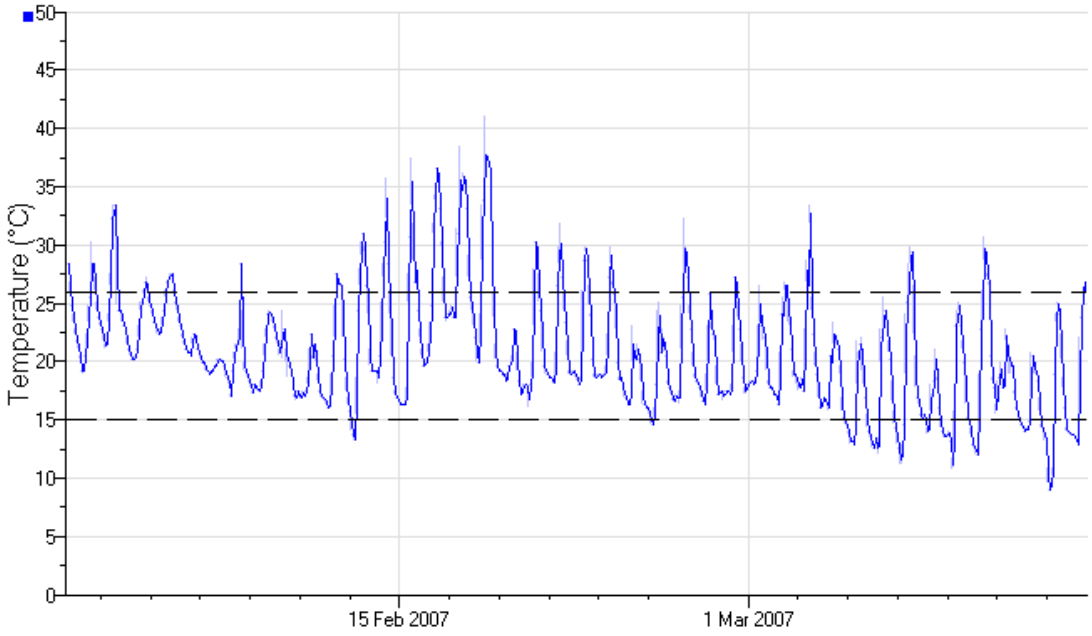
M16 Canopy facing north



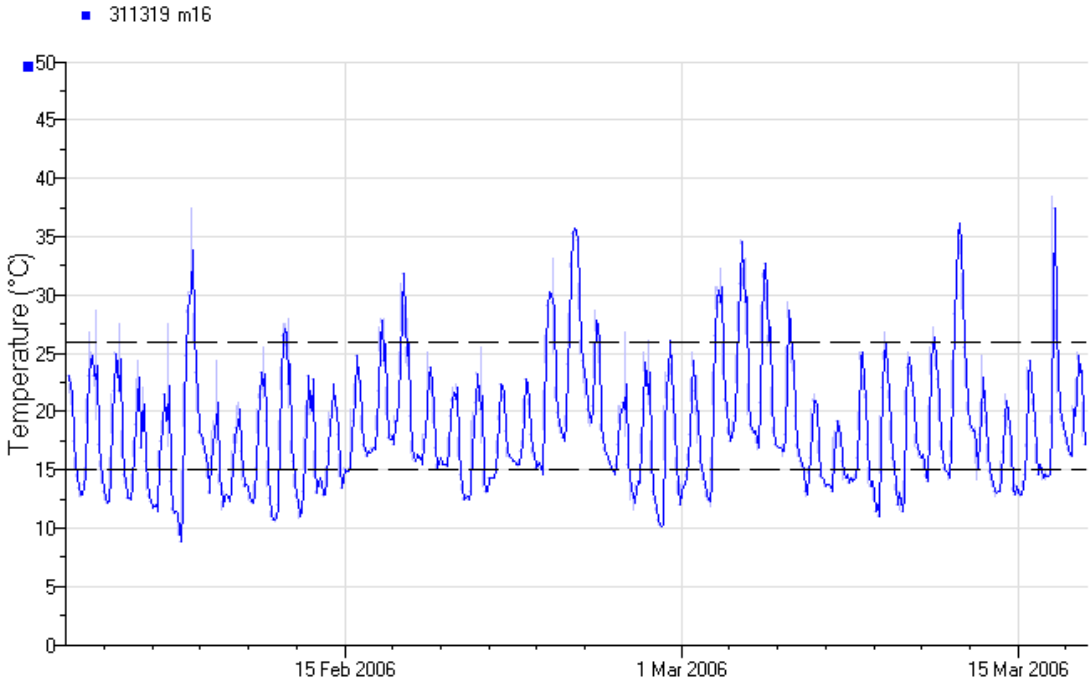
At harvest



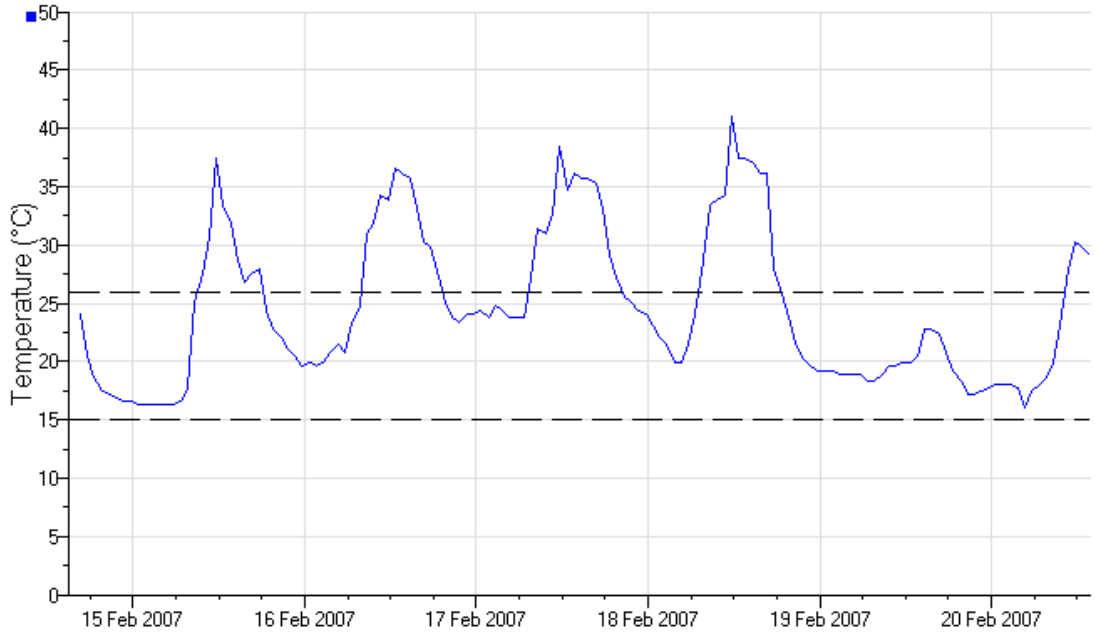
M16 In 07



M16 in 06 Protected from west by a hill

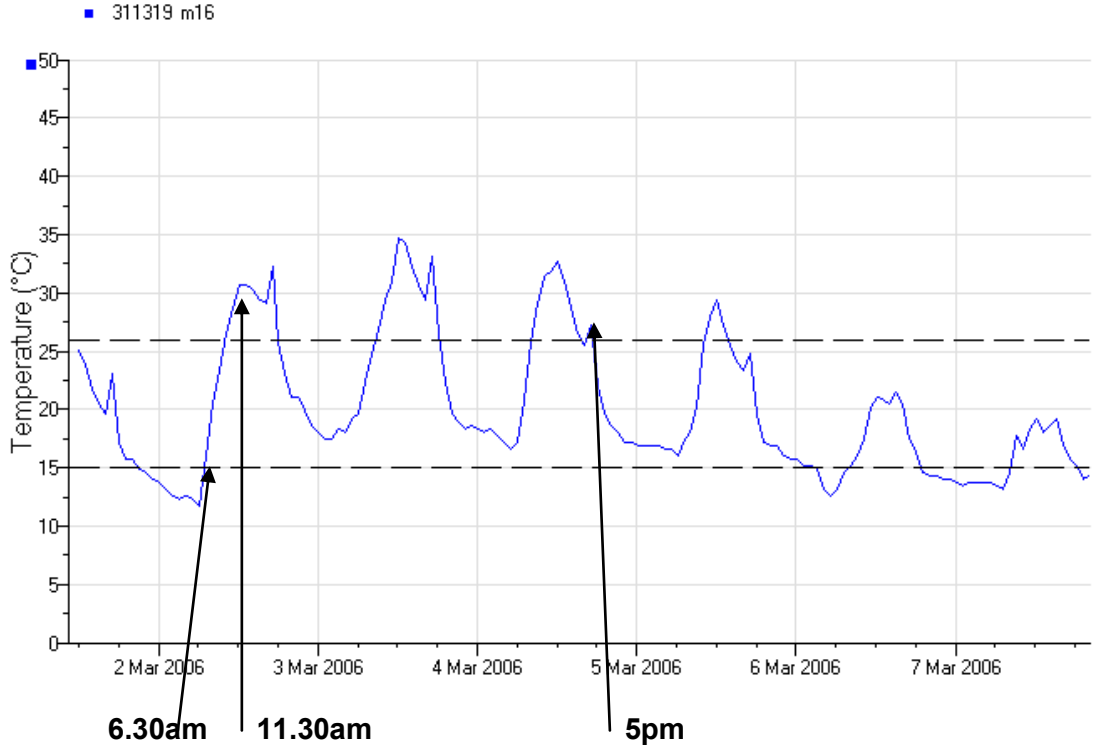


M16 Bunchzone temperatures in a hot week in 07



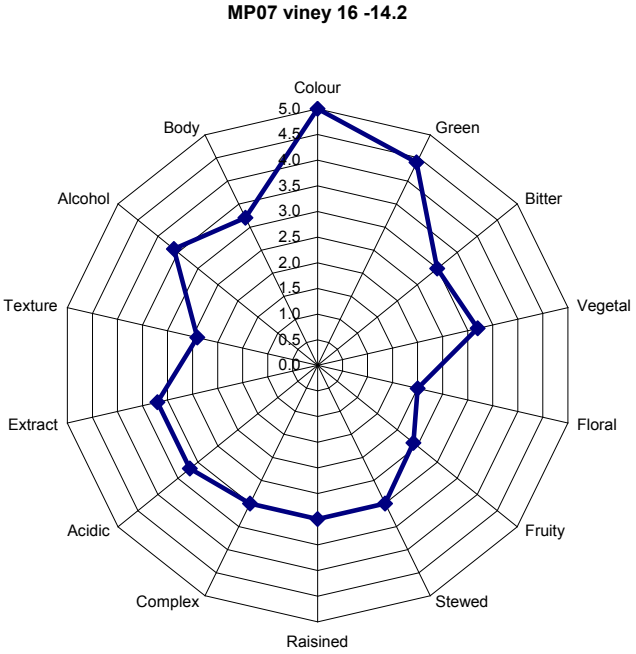
M16 Bunchzone temperatures in a hot week in 06

Protection against hot northern sun. Sun comes to the southern plucked grapes at 5pm



07: clean, consistent sample, **some shrivel,** low acid and ripe flavours with some woody/herbal/parsley skin flavour.

Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
16	34	some	0.75	3.7	5.6	23.2	12.9	1.00	0.91	0.33	3.0	2.3	3.2	3.2	2.0	2.0



06:Balanced fresh pulp, grassy skins - no wine

TA	pH	State of berry	Be	weight (gms)	Pulp maturity	Pulp aroma	Skin maturity	Seed maturity
7.5	3.6		12.7	1.01	2.8	3.0	2.0	2.0

M17 Veraison canopy facing east



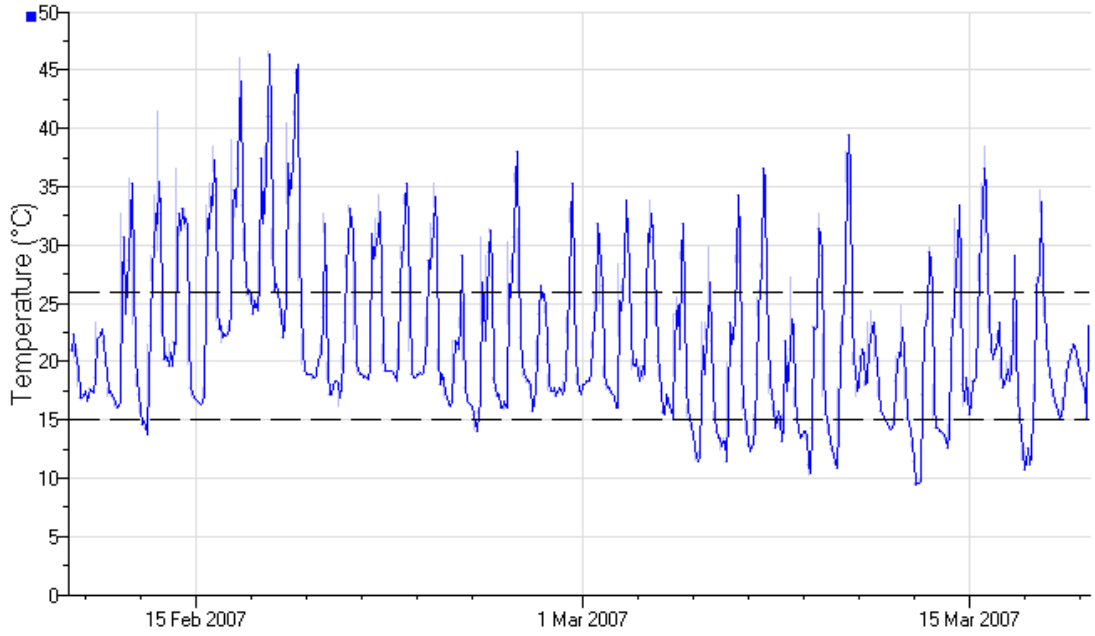
M17 Canopy facing west



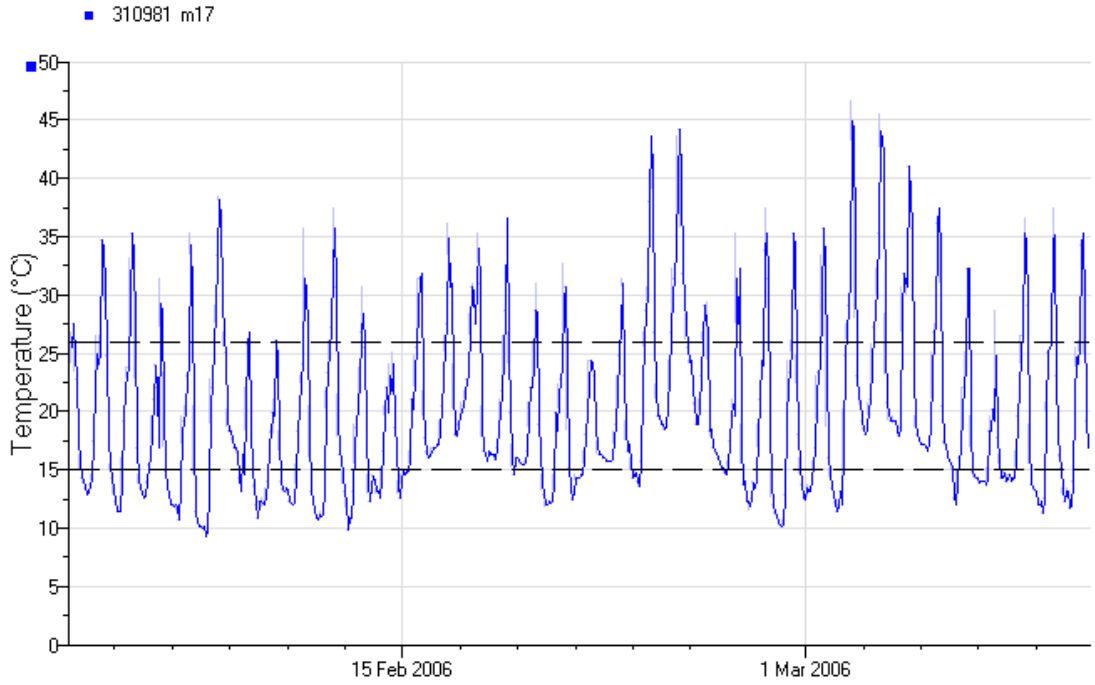
M 17 after harvest



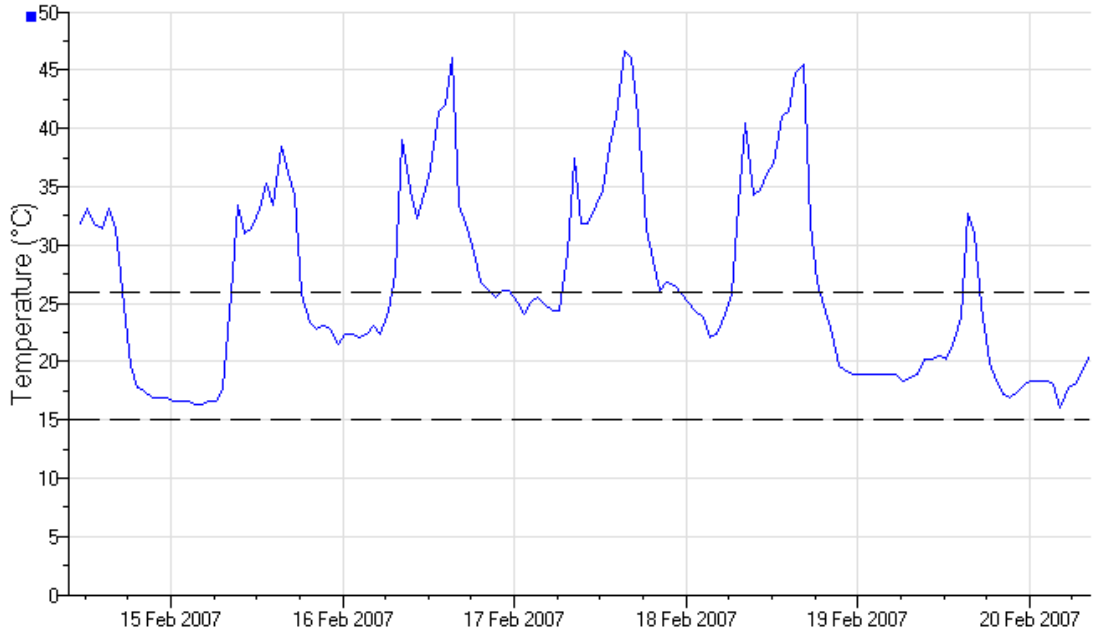
M17Bunchzone temperature in 07



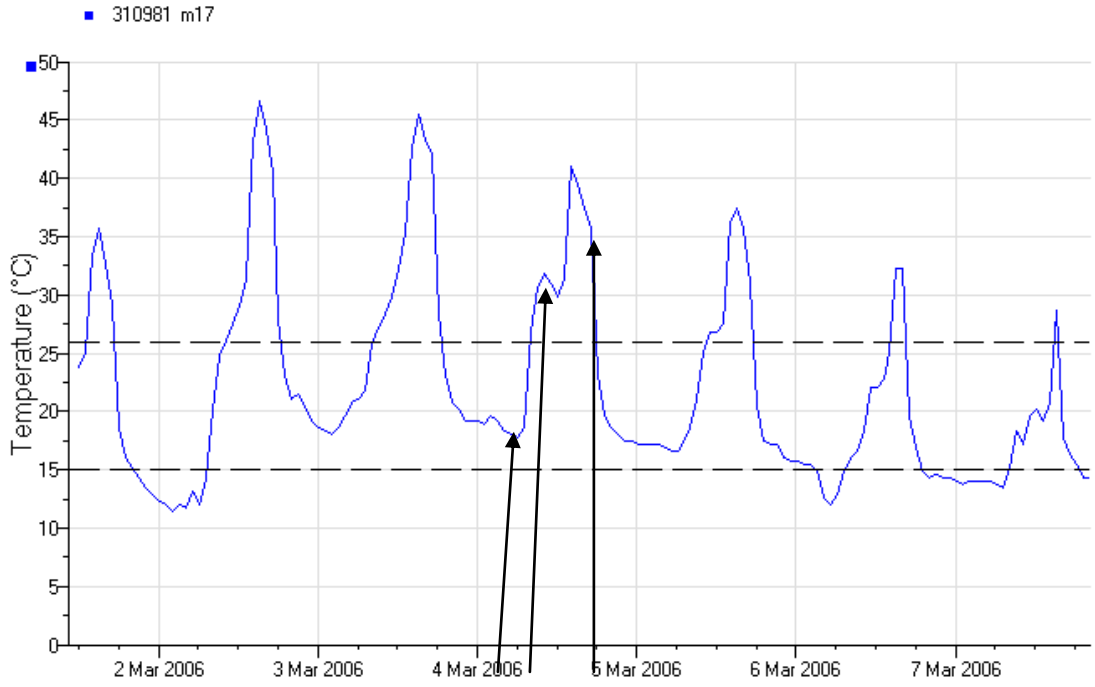
M17 in 06



M17 Bunchzones in a hot week in 07



M17 Bunchzones in a hot week in 06

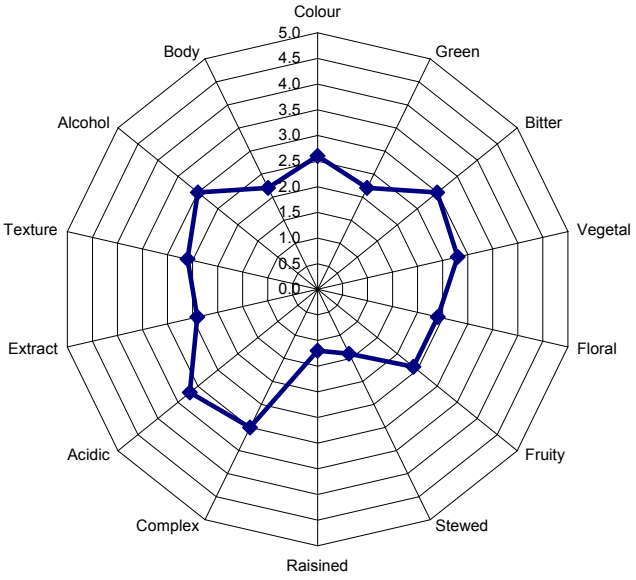


6am 10am 5pm

07: clean, large berries and tight bunches, **some shrivel**, juicy/ripe/jammy flavours- intense with some spicy/tangy skins.

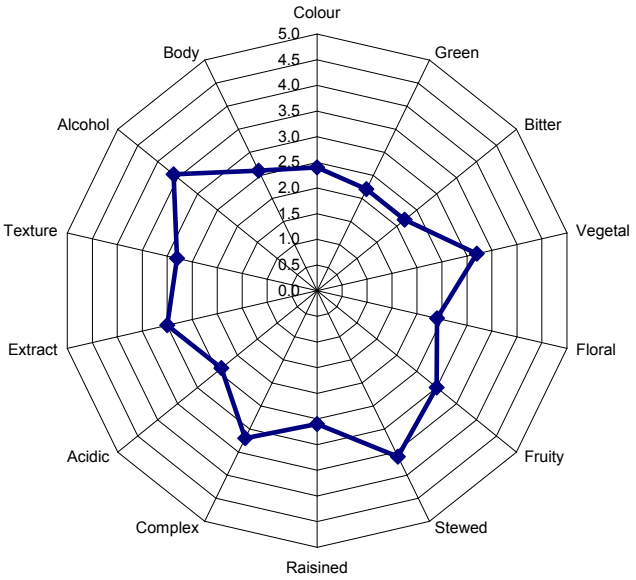
Site	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
17	36	some	0.83	3.8	5.9	23.4	13.0	0.82	0.97	0.27	2.3	2.7	3.0	3.0	2.2	2.2

MP07 viney 17 - 13



06:

M17 13.9

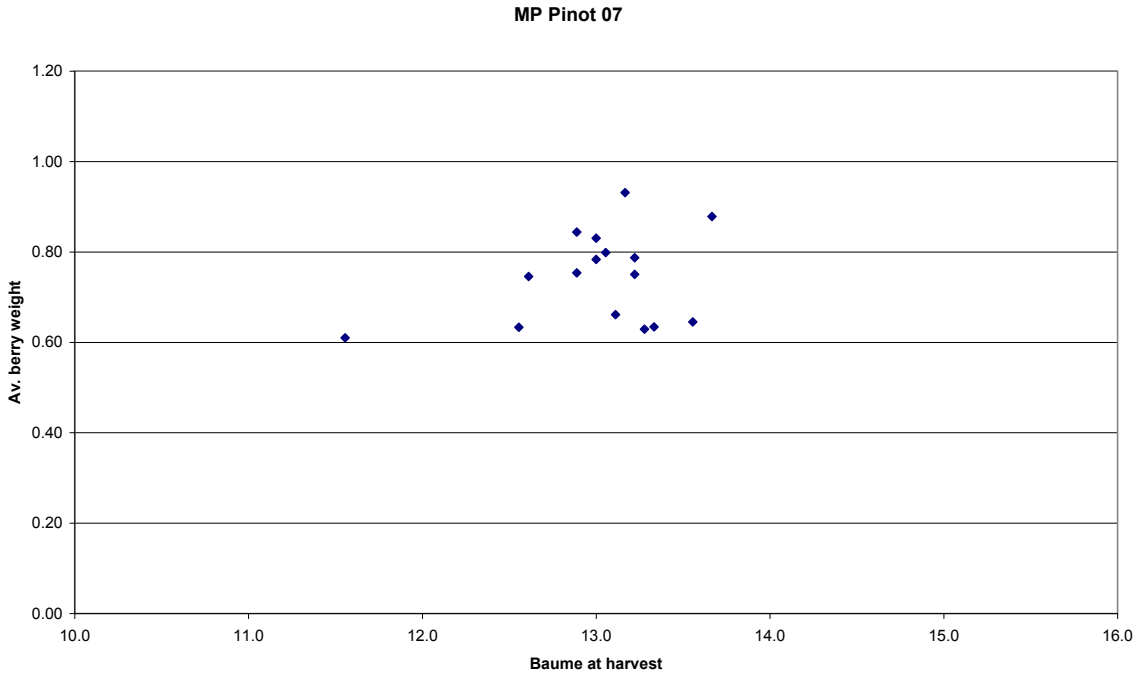


MLF incomplete SO2 bleaching

Chemical analysis of berries –synopsis and correlations

Baumé

Fig. 14a,b: Baumé at harvest was somewhat lower in 07 with a narrower spread, and in both years not related to berry weight



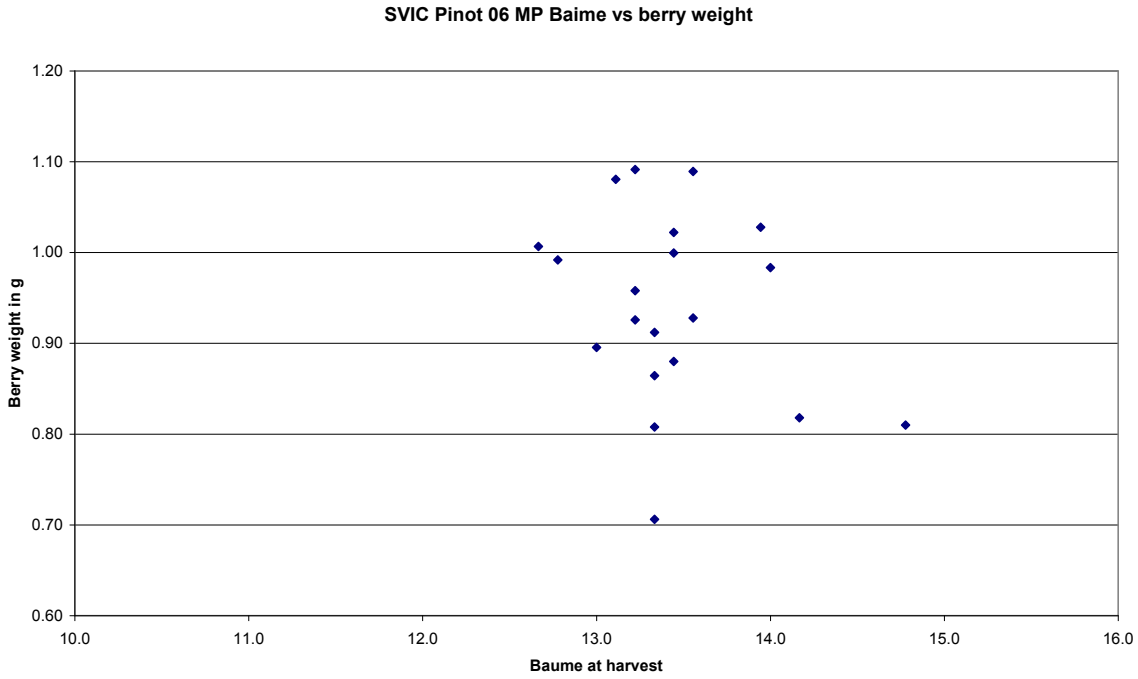


Fig. 15: More cumulative degree h in the bunchzone (brought about by warmth and hangtime) has a 50% chance of providing a higher Be at harvest.

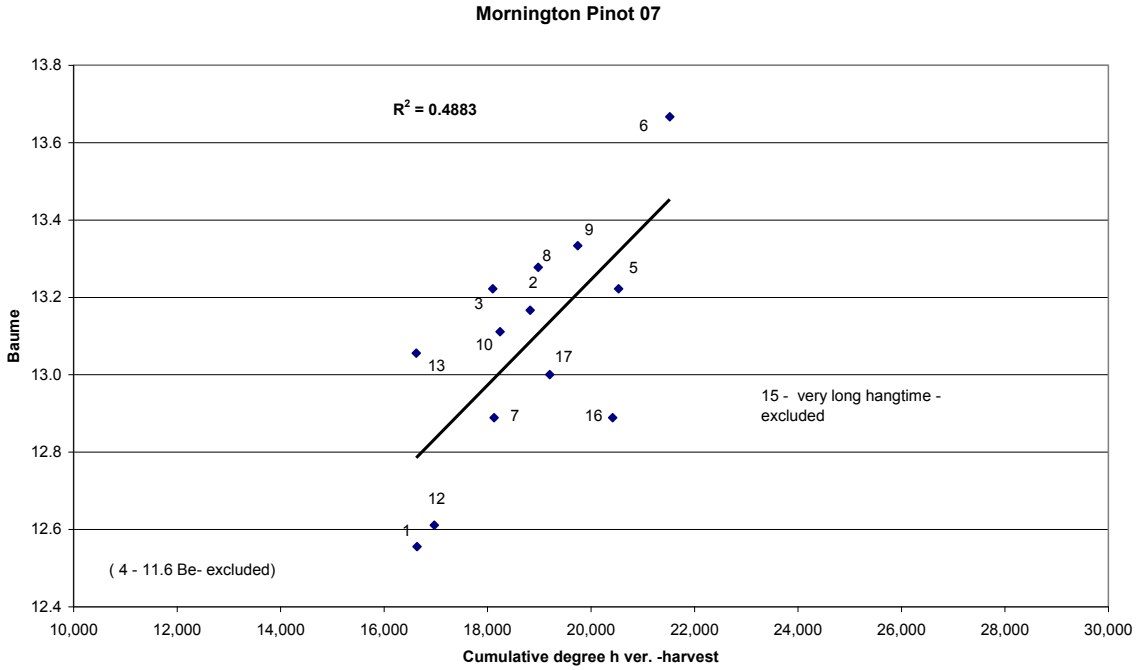


Fig. 16: Higher Be is not related to higher colour.

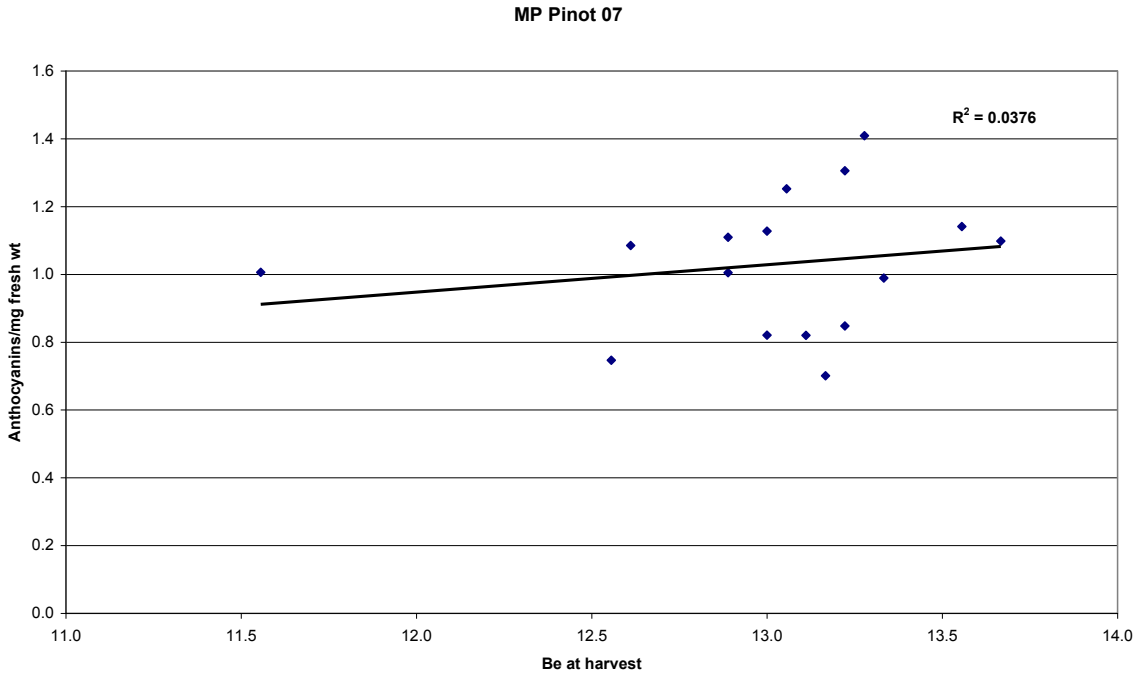


Fig. 17; Be was unrelated to vine balance

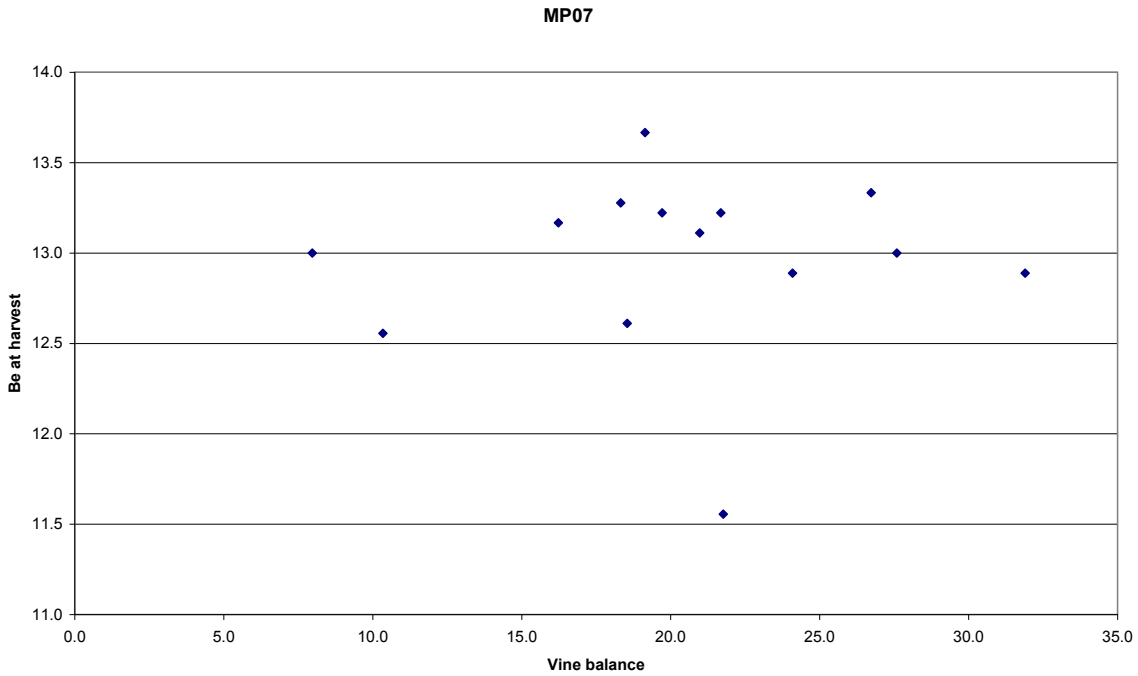


Fig 18: Be was unrelated to fruit wt per shoot

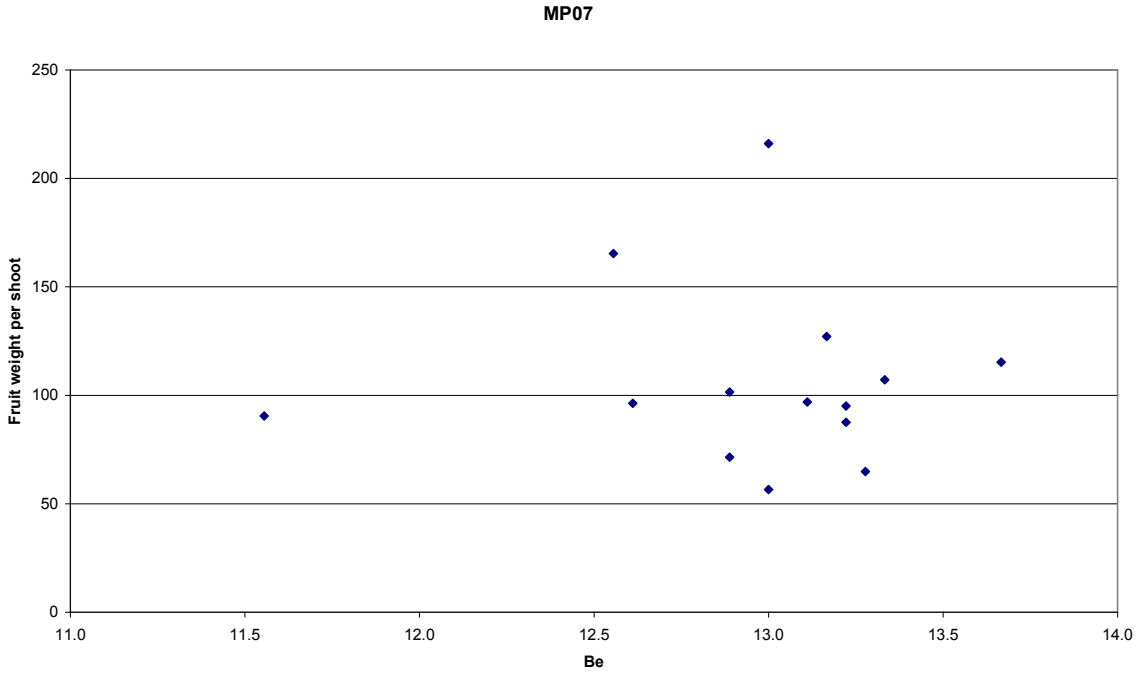
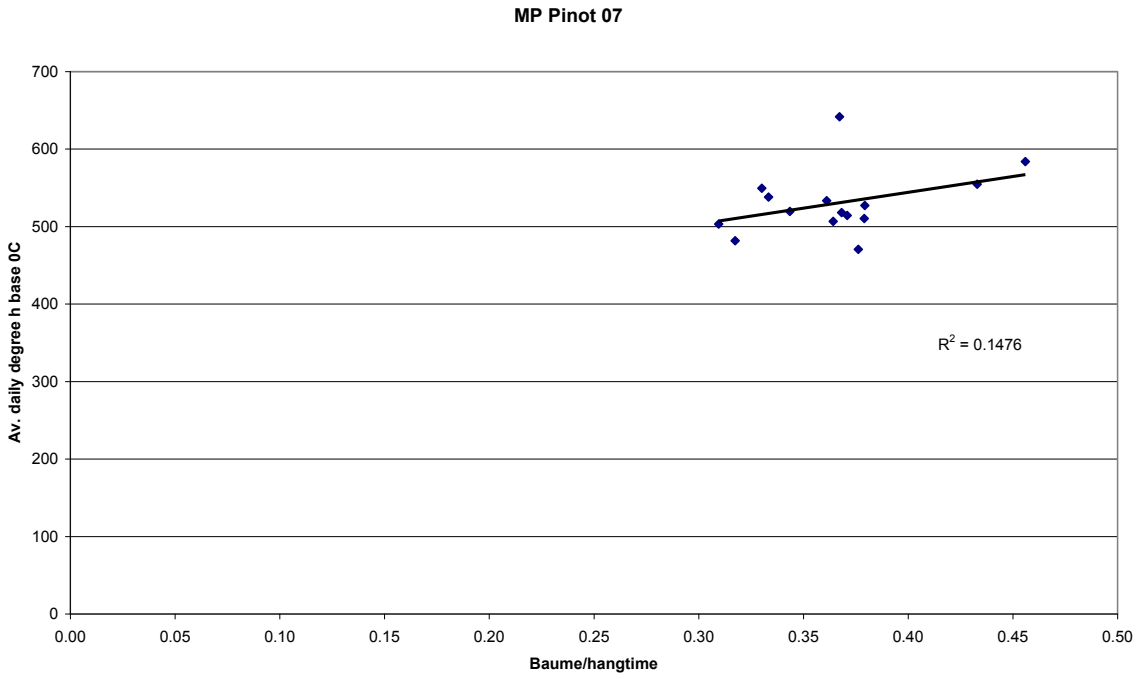


Fig. 20a,b: A good measure to compare physiological processes is a ratio. Sugar loading (Be/day of hangtime) was slightly faster warmer bunchzones in both years, with absolute values in 07 twice those of 06.



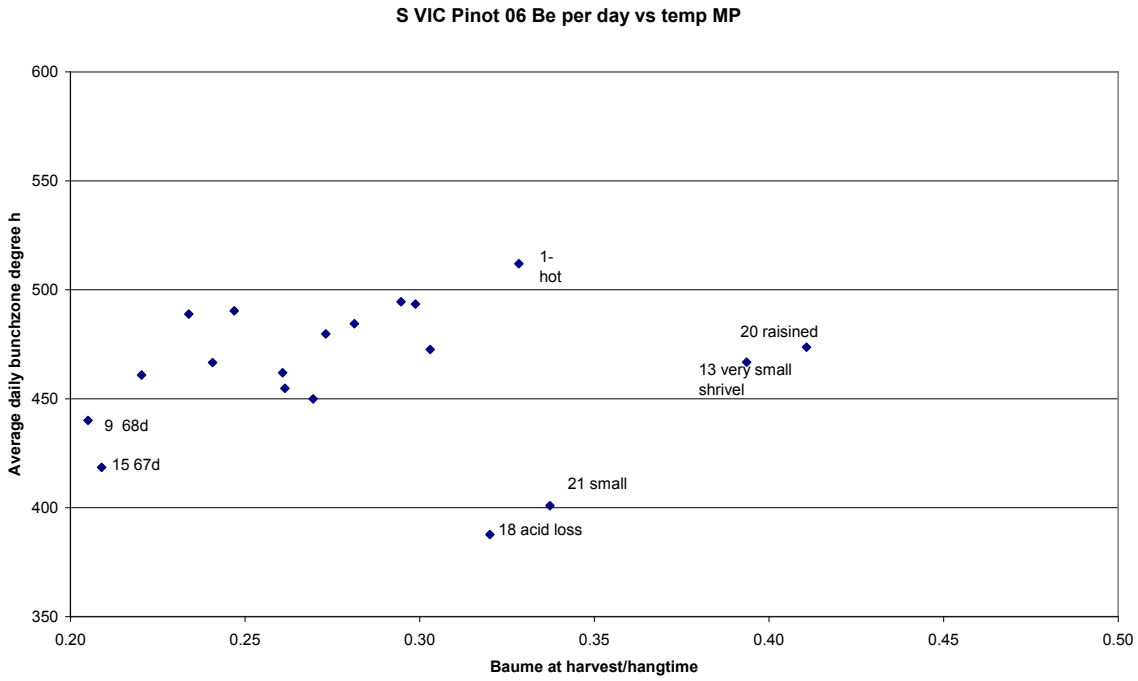


Fig. 21: Sugar loading was unrelated to active leaf area

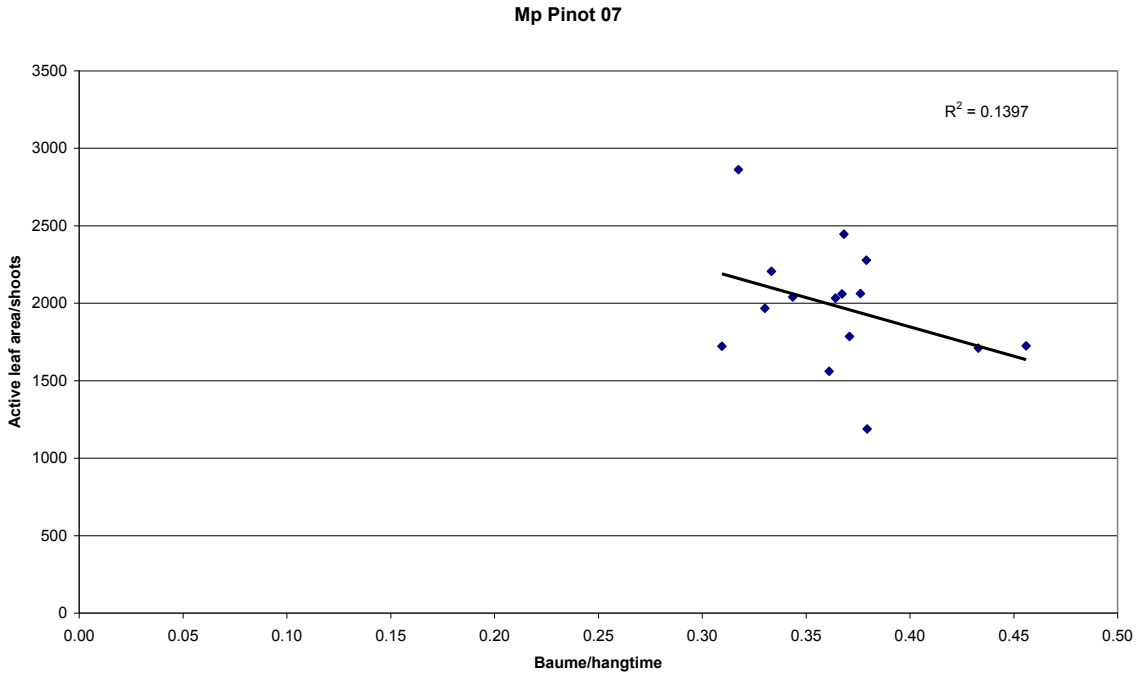


Fig. 22: Sugar loading was unrelated to fruit weight per shoot

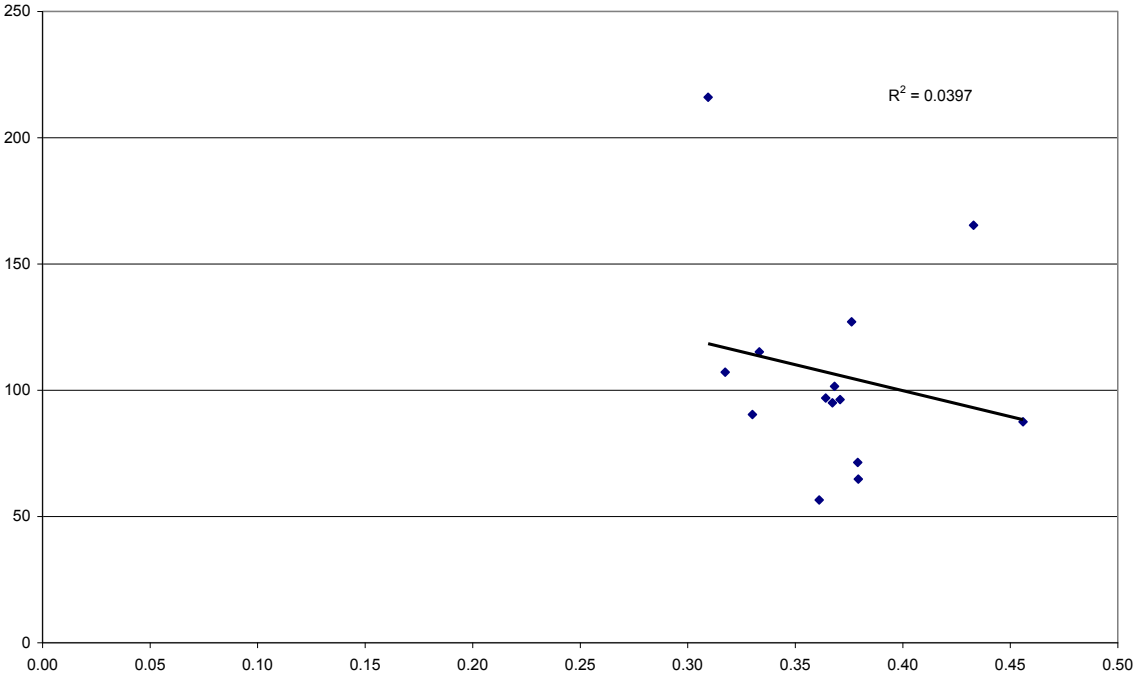
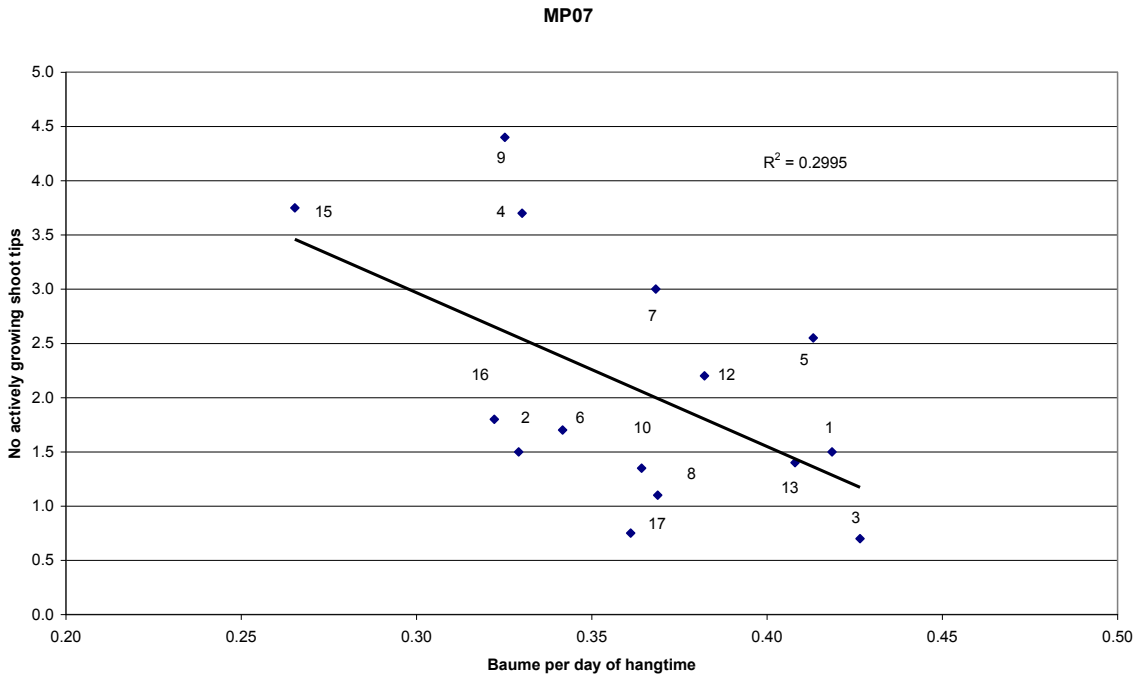
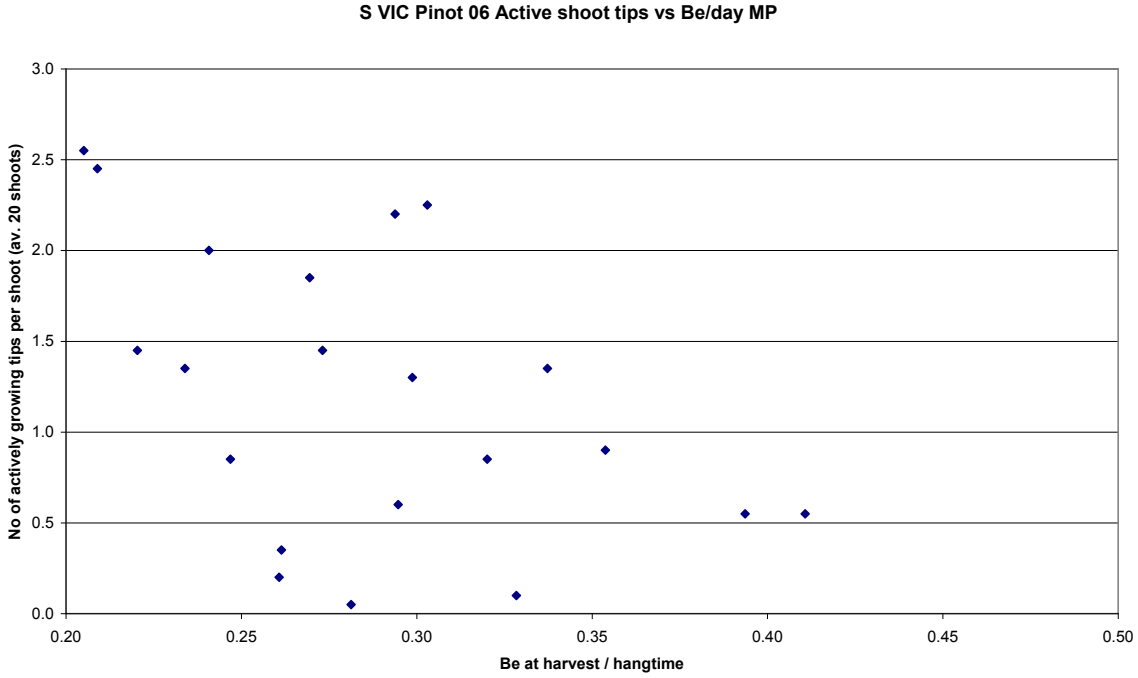


Fig. 23a.b: In 07 the sugar loading depended on the competition from actively growing shoot tips

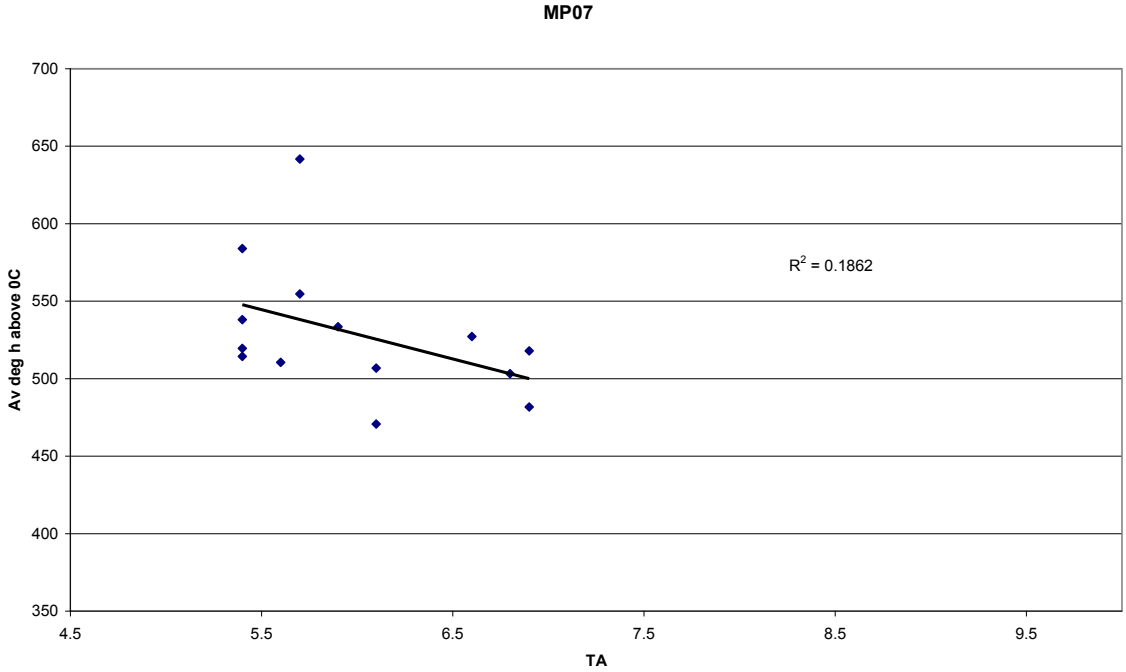


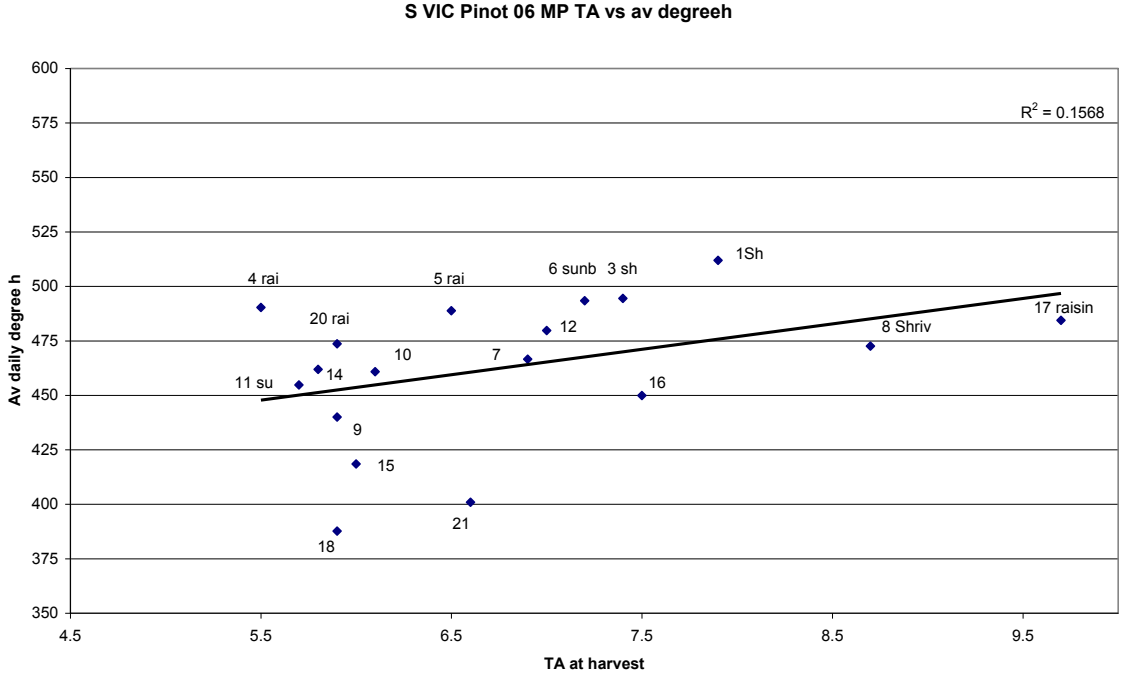
This was less in 06 but also expressed as a trend



TA

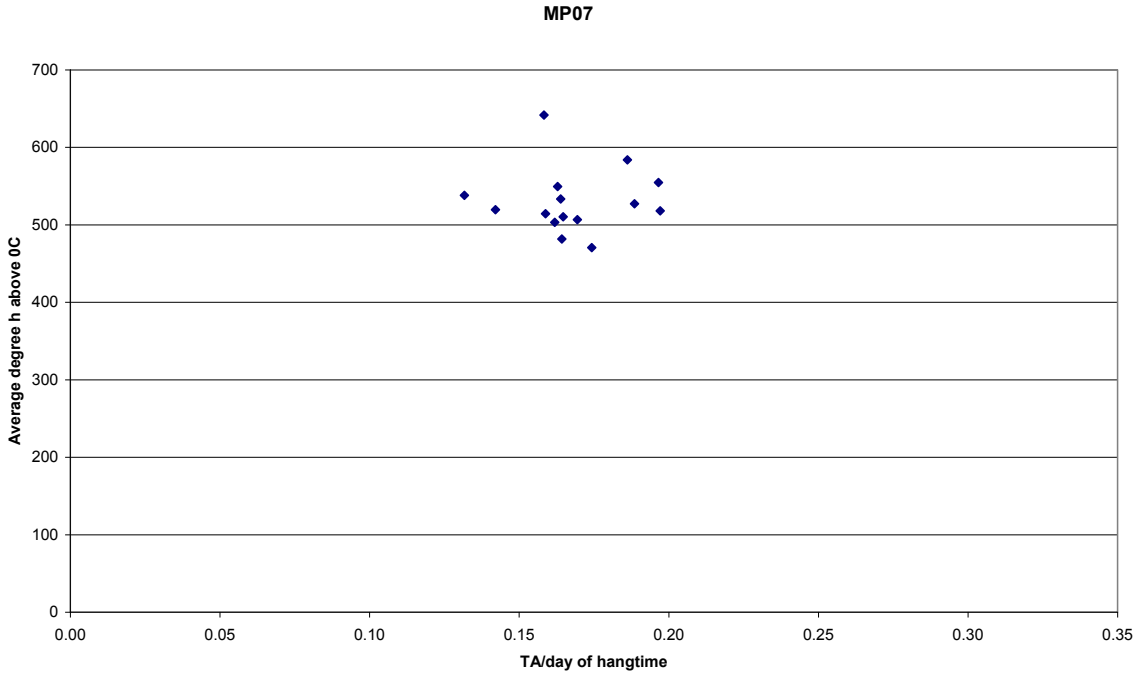
Fig. 24 a,b: In 07 TA at harvest was lower, and in both years unrelated to average bunchzone degree h above 0C.





In 2006, some berries in the MP were harvested with high acidity – possibly due to the onset of heat damage? Shrivelled or raisined berries occurred at all TA"s in the 475-525 average daily degree brackets.

Fig. 25 a, b: Acid depletion (lowering of TA/day) was faster in 07 but independent of average temperatures (day and night) in both years.



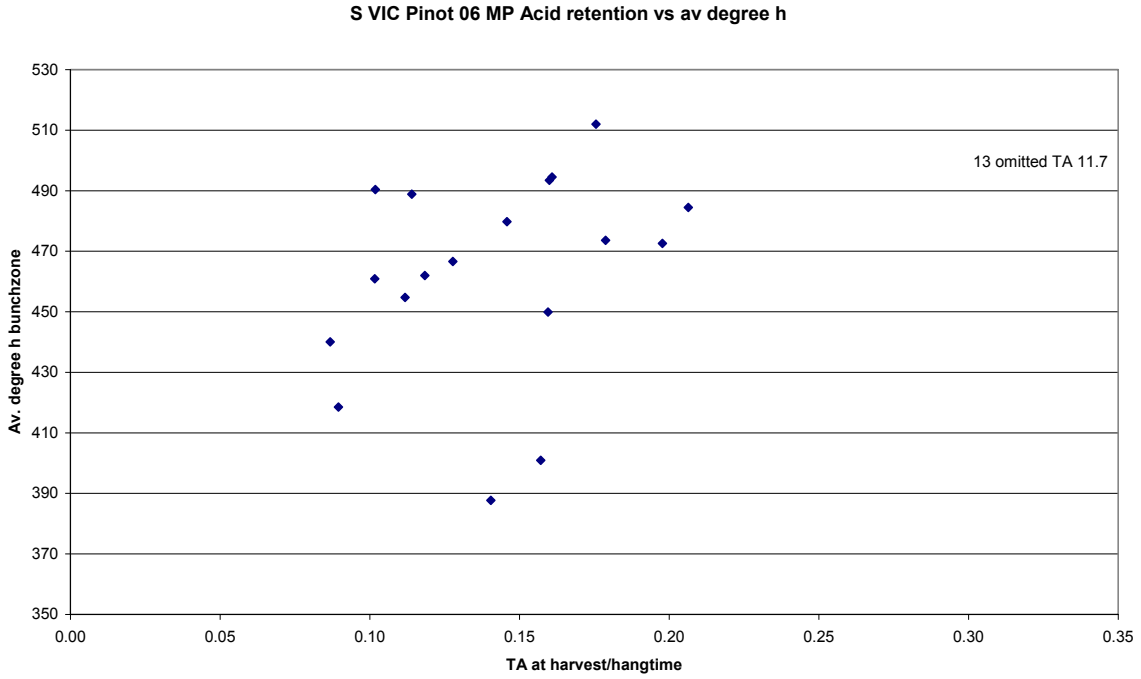
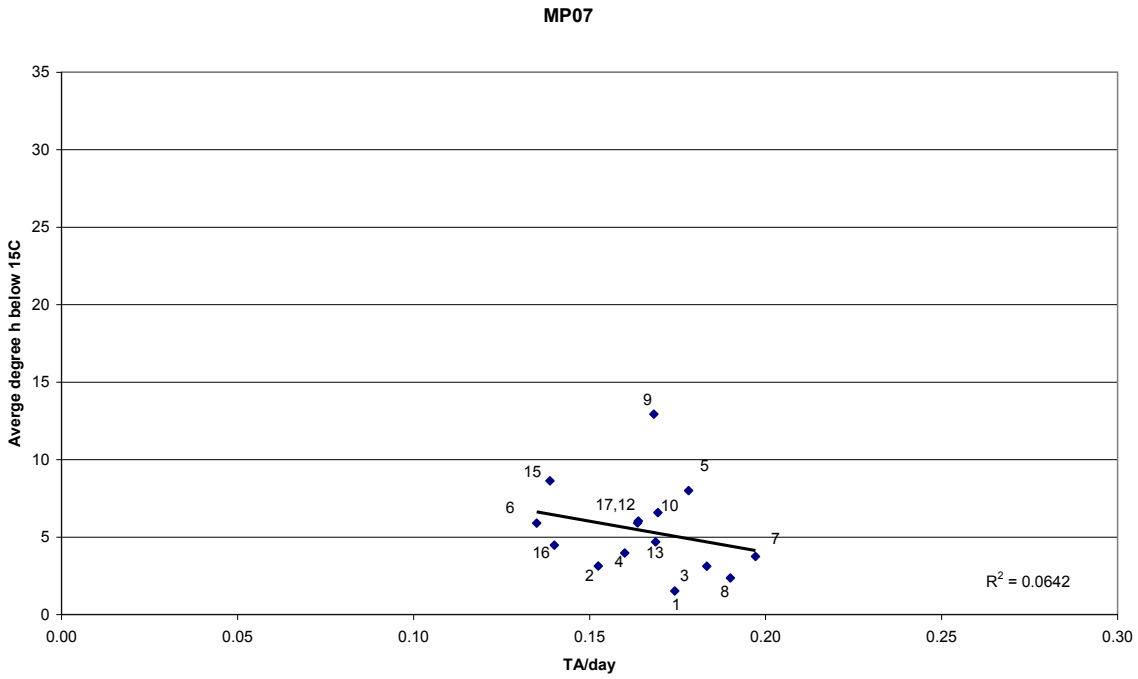
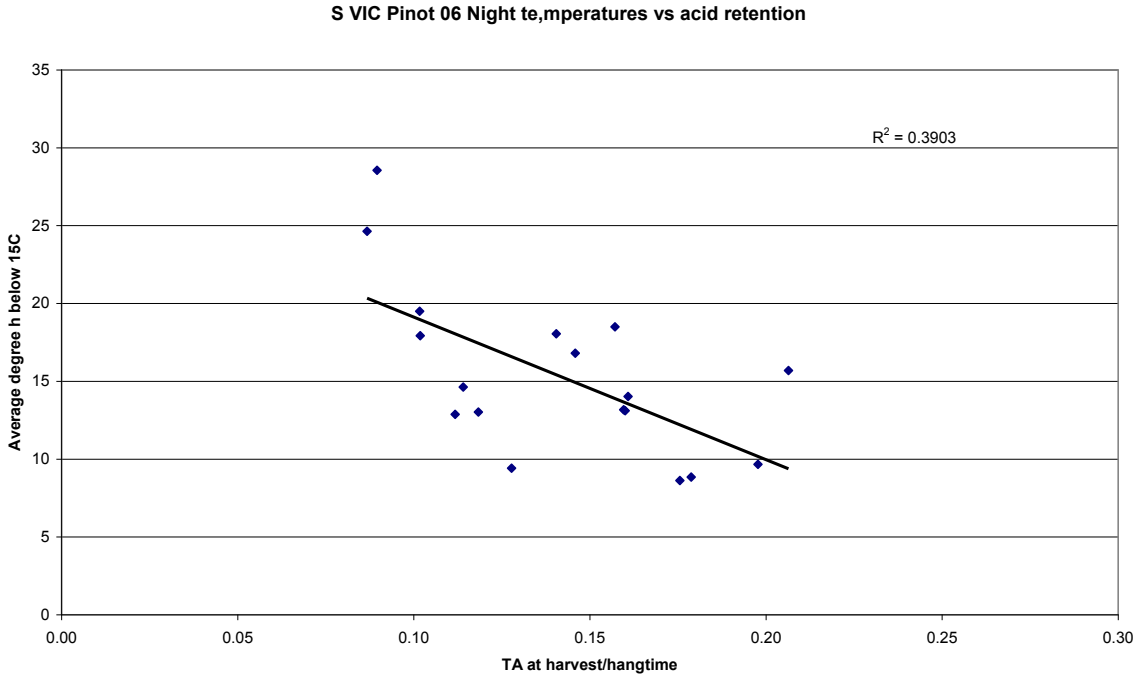


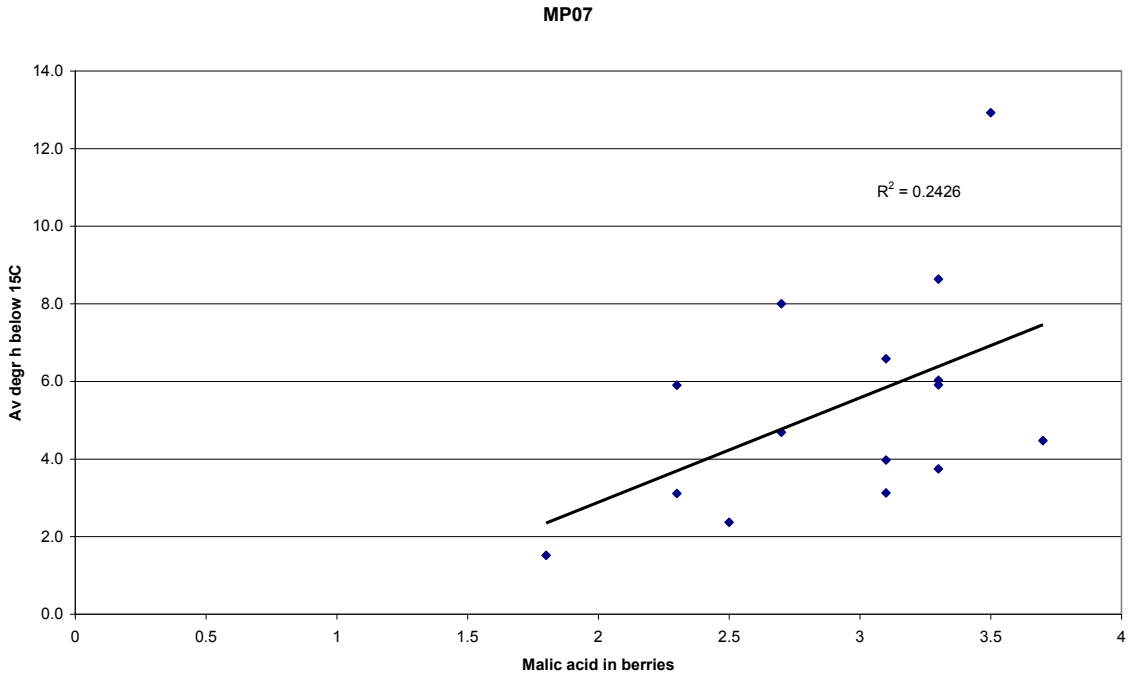
Fig. 26a.b In 07 acid depletion was slower (higher ratio of acid to days) in cooler night bunchzones, as in last year, where the spread was wider.





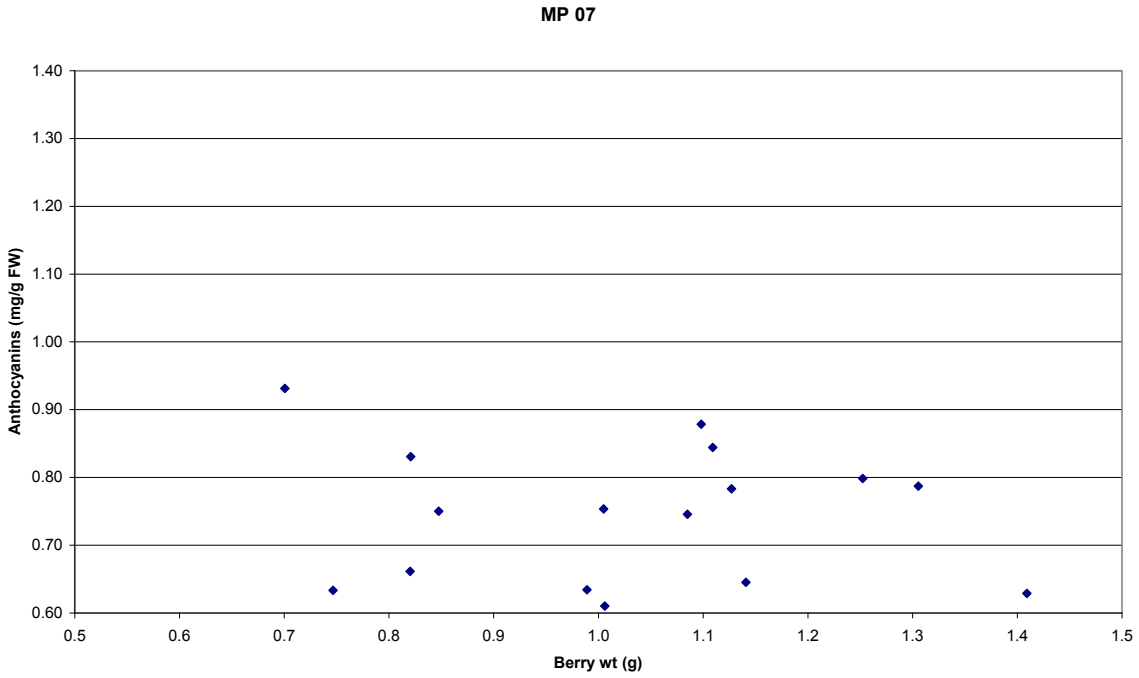
Malic acid

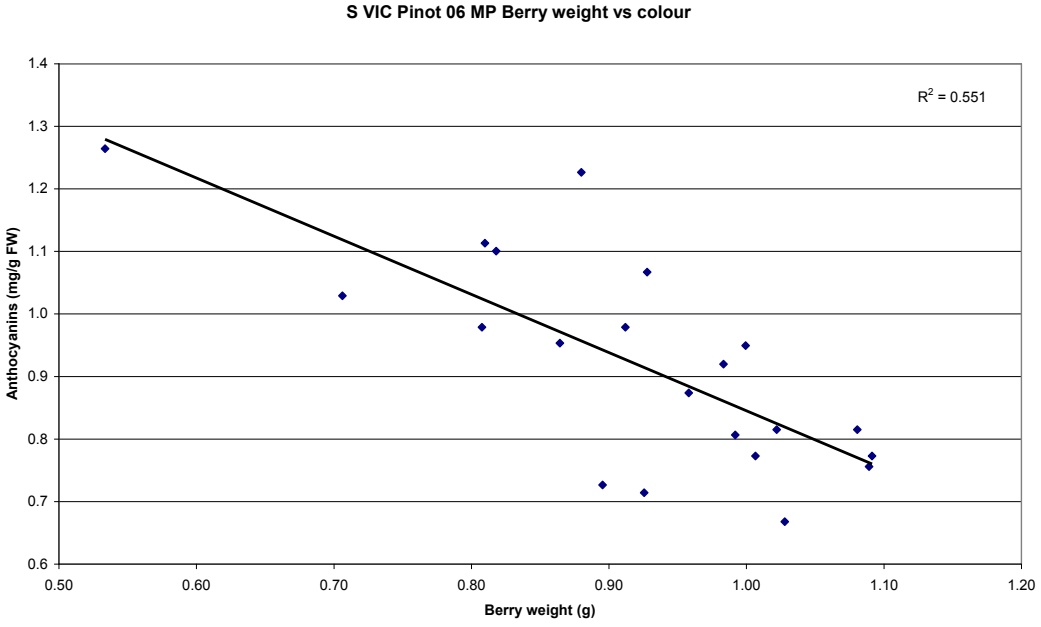
Fig. 26c: Malic acid in berries was higher in bunches from cooler vineyards (high number of average degree h below 15C)



Colour

Fig. 27a,b: In 07 colour was unrelated to berry weight. In 06 higher colour per g FW occurred in smaller berries.





Colour was unrelated to fruit load per shoot or vine balance (as in NE VIC in the cooler season 05). In 07 there was no correlation between average degree h above 26C and colour, as there were no really cold bunches (in 06 bunches from low average degree hours or which were rather large had poor colour).

Fig. 28a: Colour potential is best expressed by colour per day of hangtime. There may be an optimum temperature for best colour. Two vineyards with low colour in bunches had also the two coldest bunchzones. Hot bunchzones can lead to shrivel (5). Vineyard 17 and 1 were drought stressed.

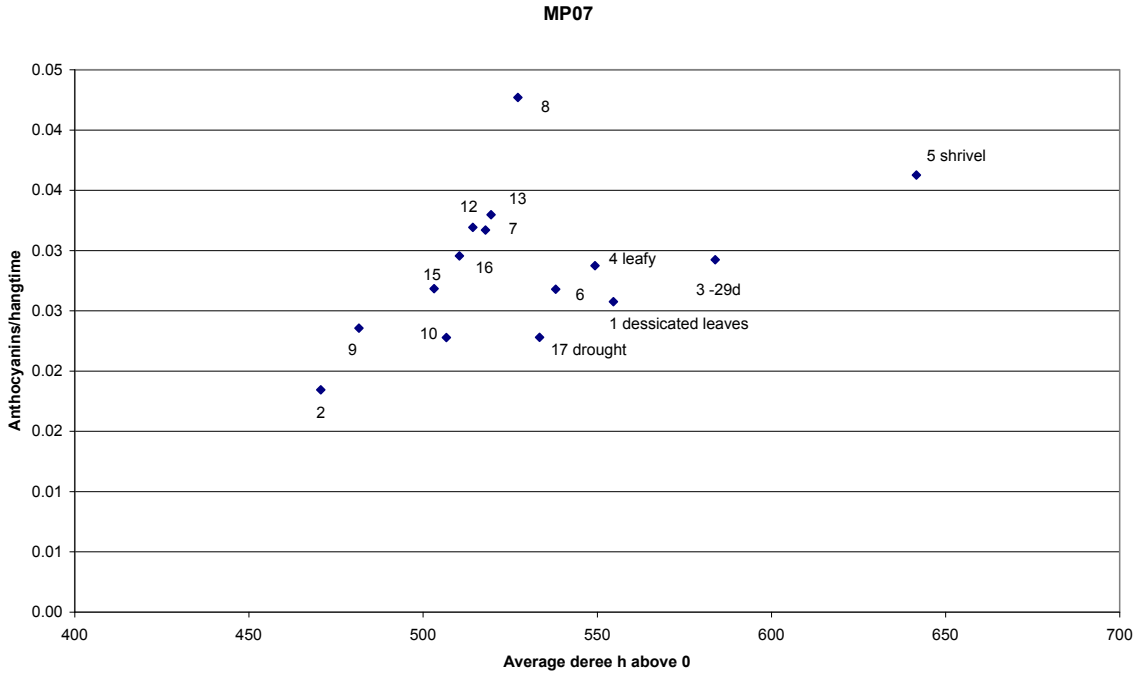


Fig. 28b: Last season's data - colder season (1, 19 and 20 deleted due to short logger times) berry weights and shrivel influence the curve

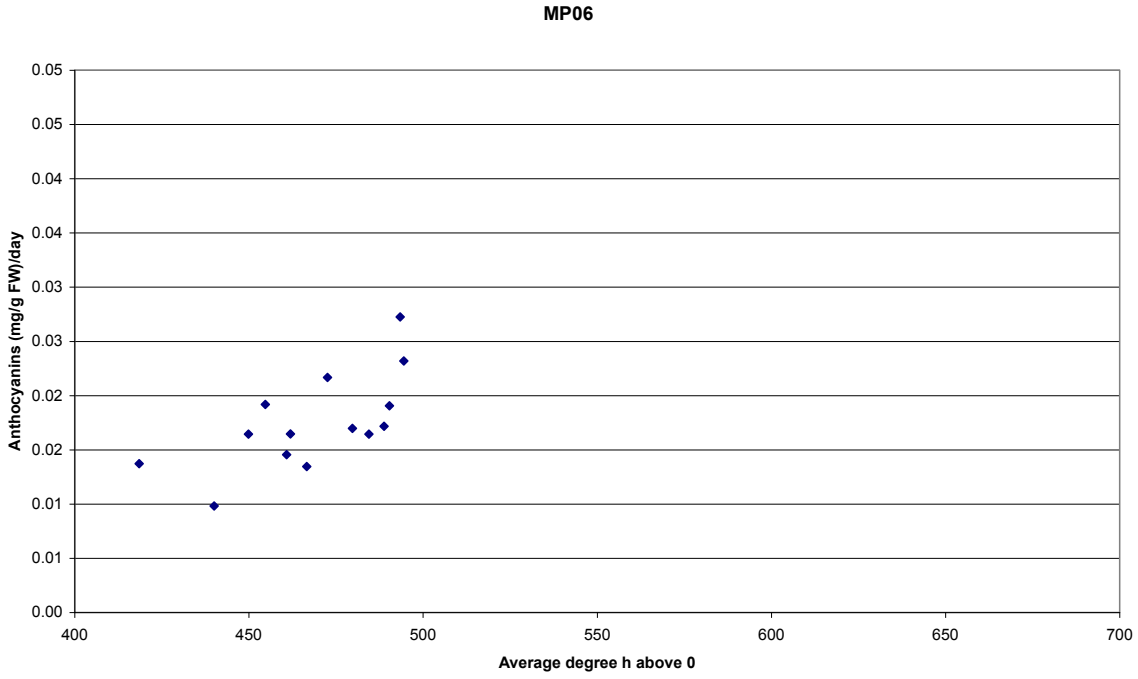


Fig. 29a: Colour formation is slower in bunches from vineyards where there are many cold nights.

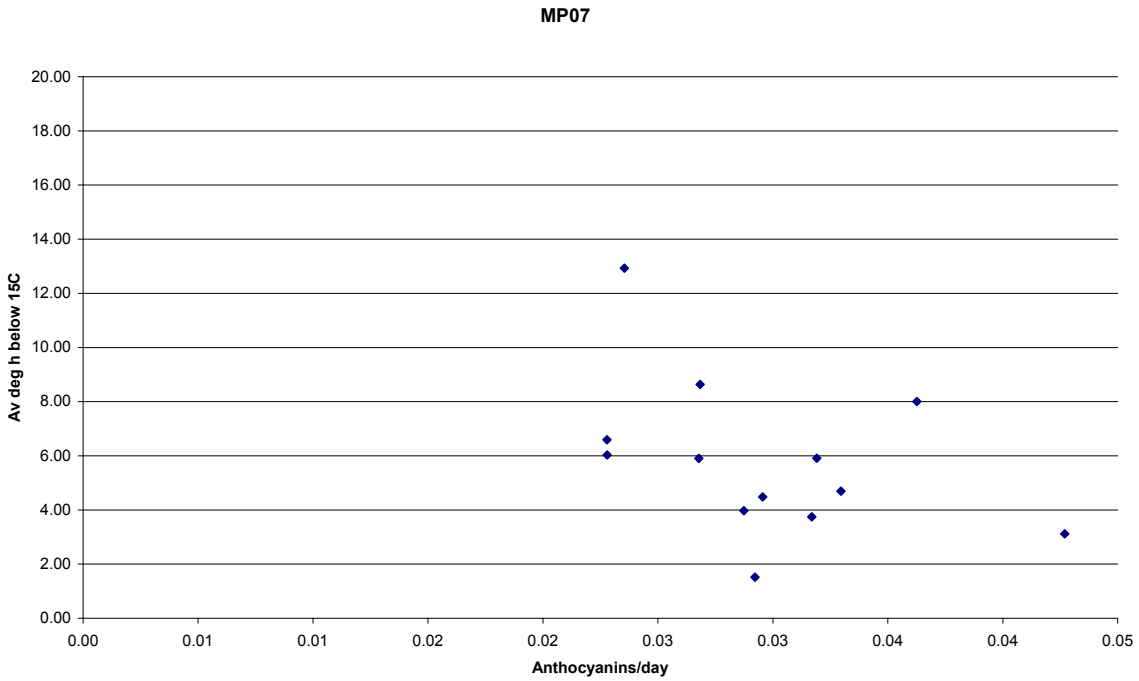


Fig. 29b: Last year's data confirm this trend (1, 19 and 20 deleted due to short logger times) but also berry weights and shrivel influence the colour

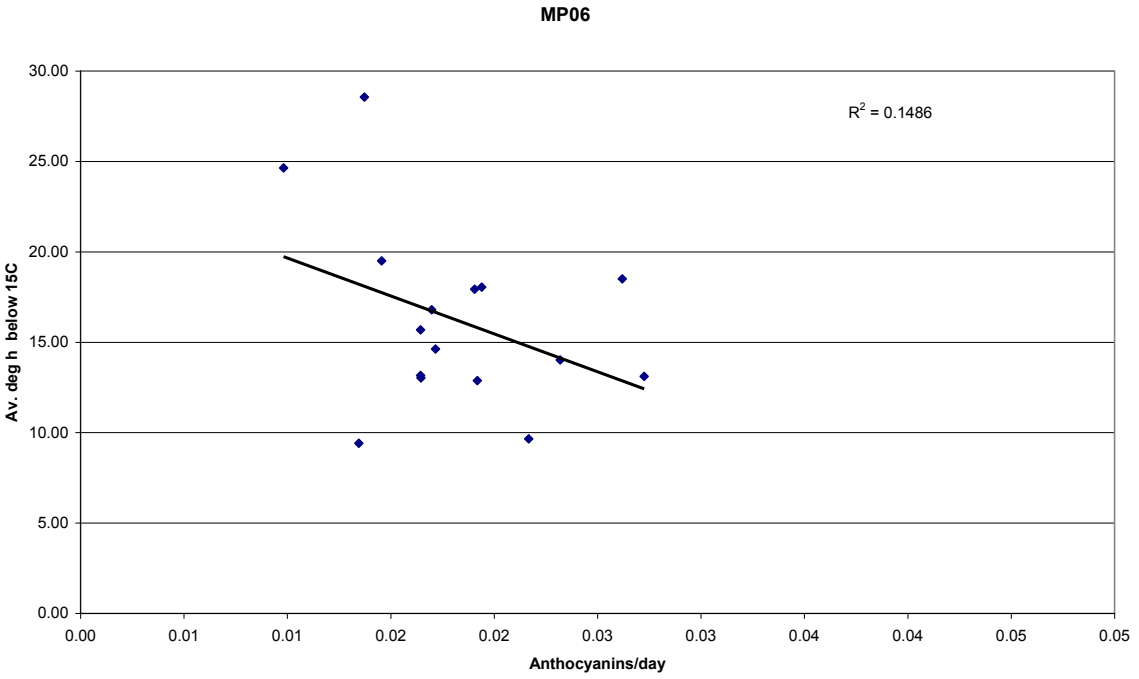


Fig. 30: Opening up the bunchzone E and S decreased the average hours below 15C

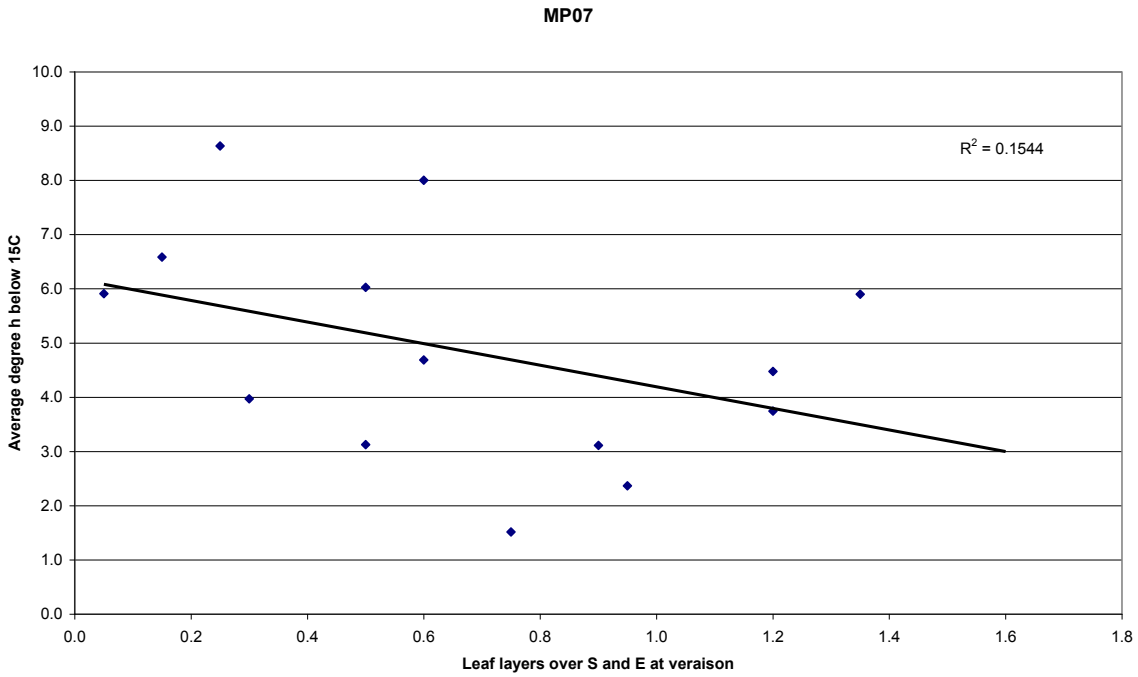


Fig. 31: Leaf layers E and S at veraison may display a slight colour optimum in dappled light but this is not statistically significant.

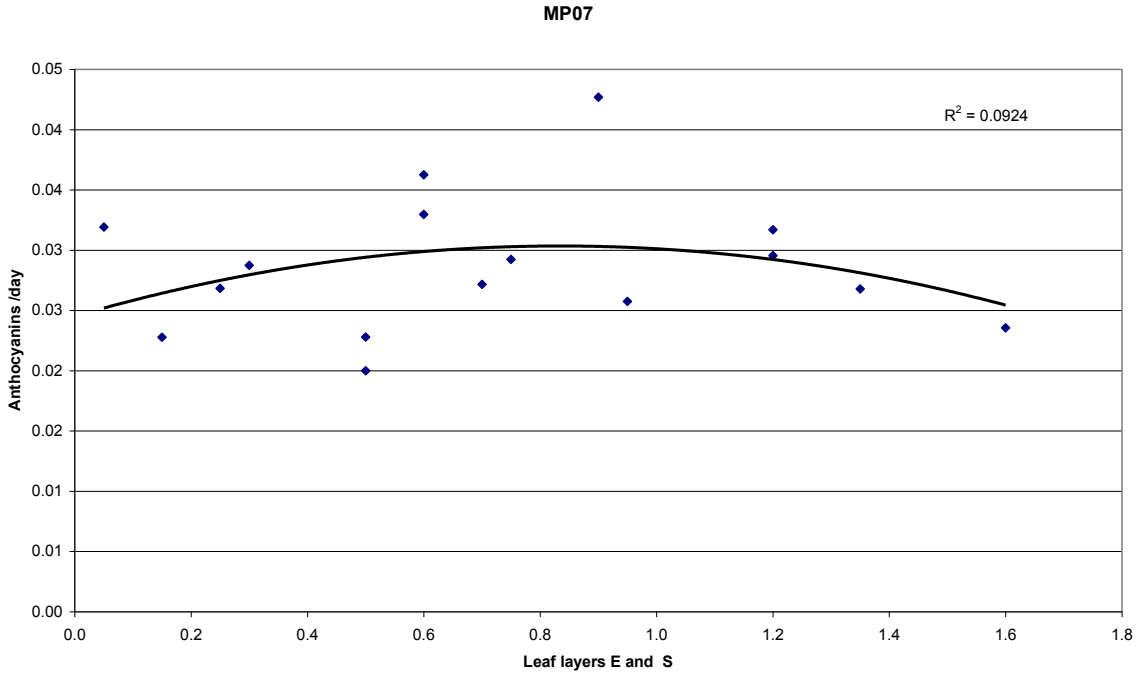


Fig. 32: Leaf cover on N and W side at veraison did not influence colour formation.

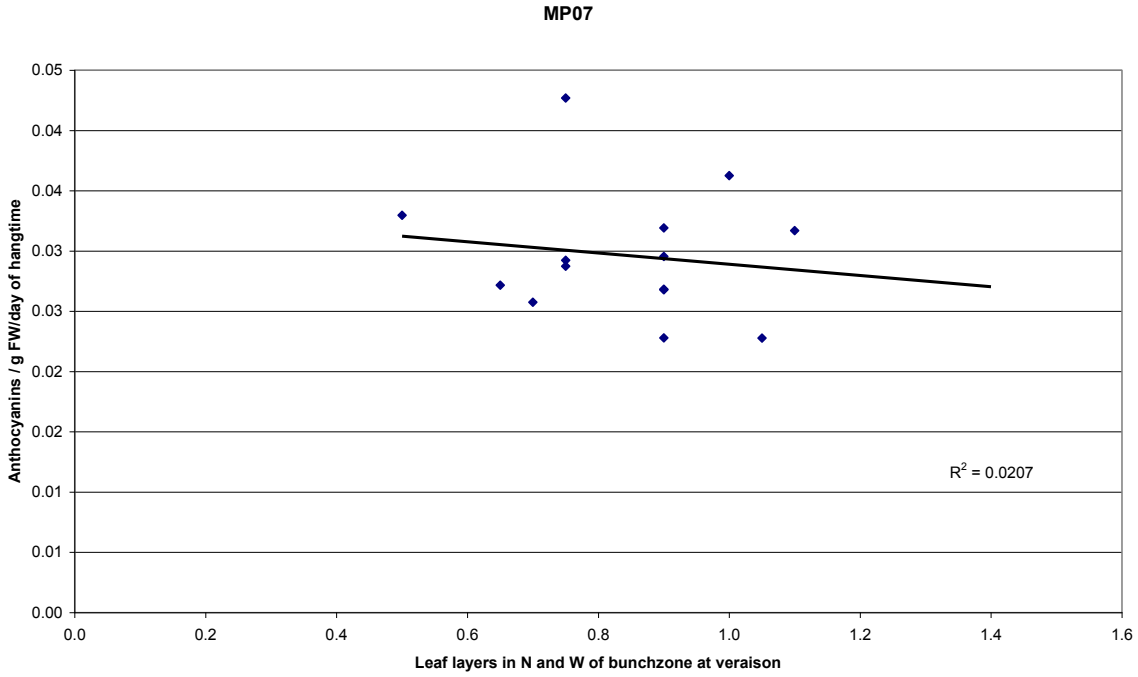


Fig. 33: Leaf cover on N and W side before harvest did not influence colour formation or loss.

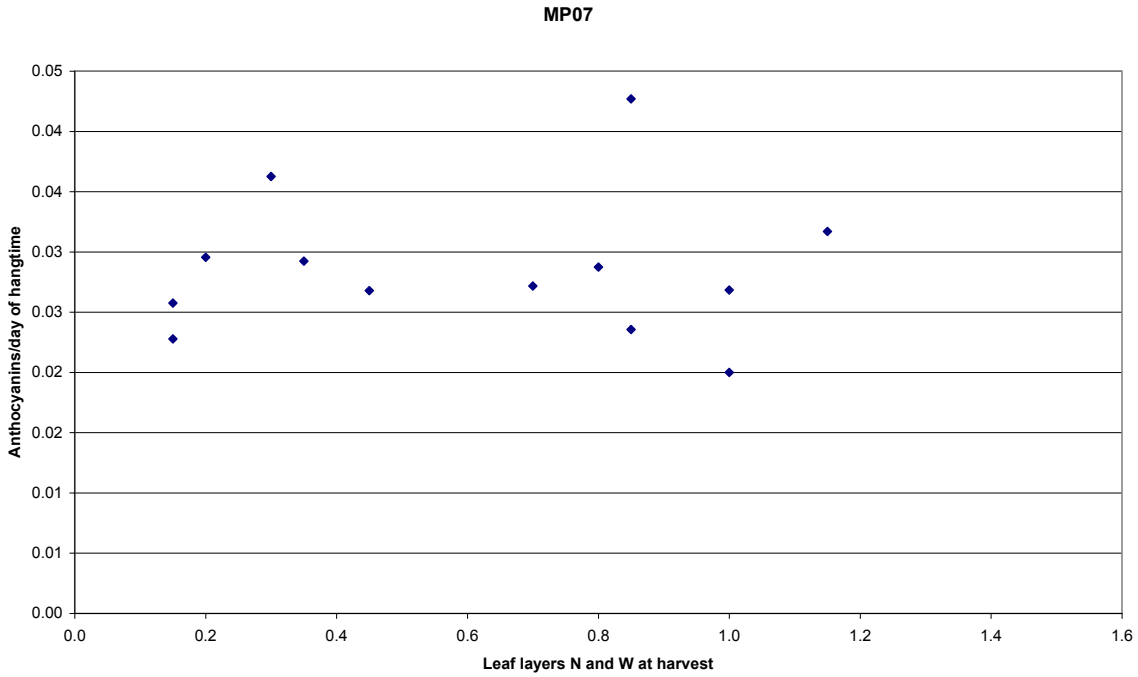
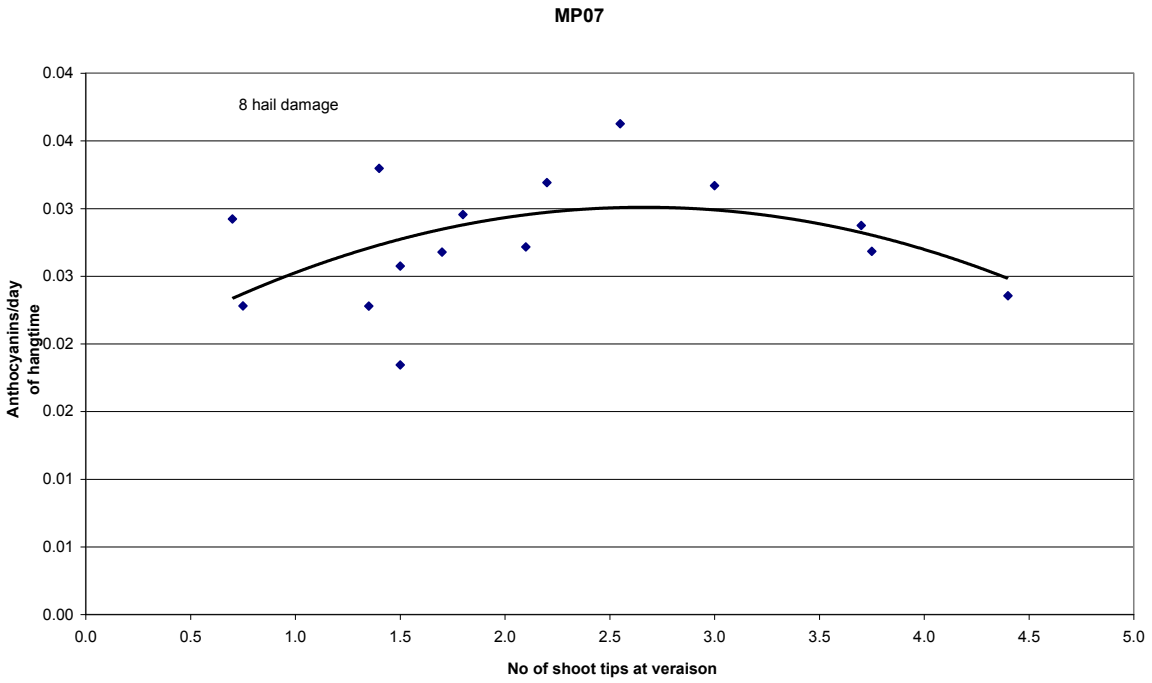


Fig. 34: There is an ideal number of growing shoot tips, fewer may lead to high exposure, and more to resource depletion.



Total Phenolics

Fig. 35: In 07 except for a group with high total phenolics/day in low average bunch warmth (9,15,10 with cold nights) there could be a trend between warmer bunchzones and better phenolic ripeness.

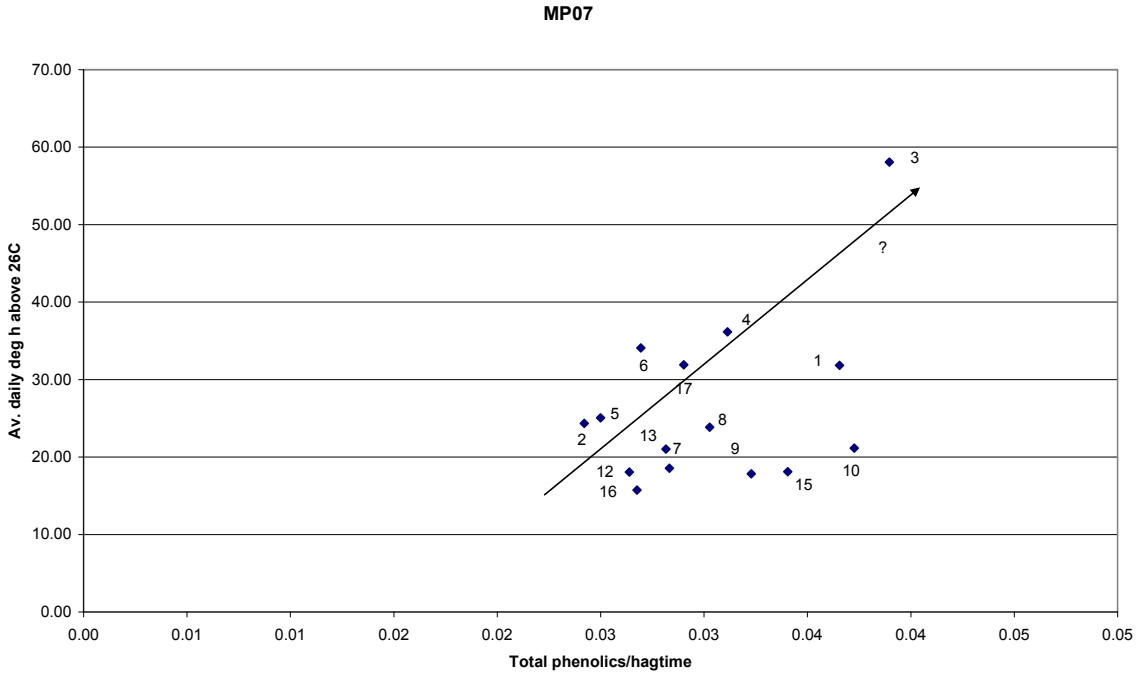


Fig. 36: In 07 higher total phenolics at harvest may be related to lower total hours below 15C

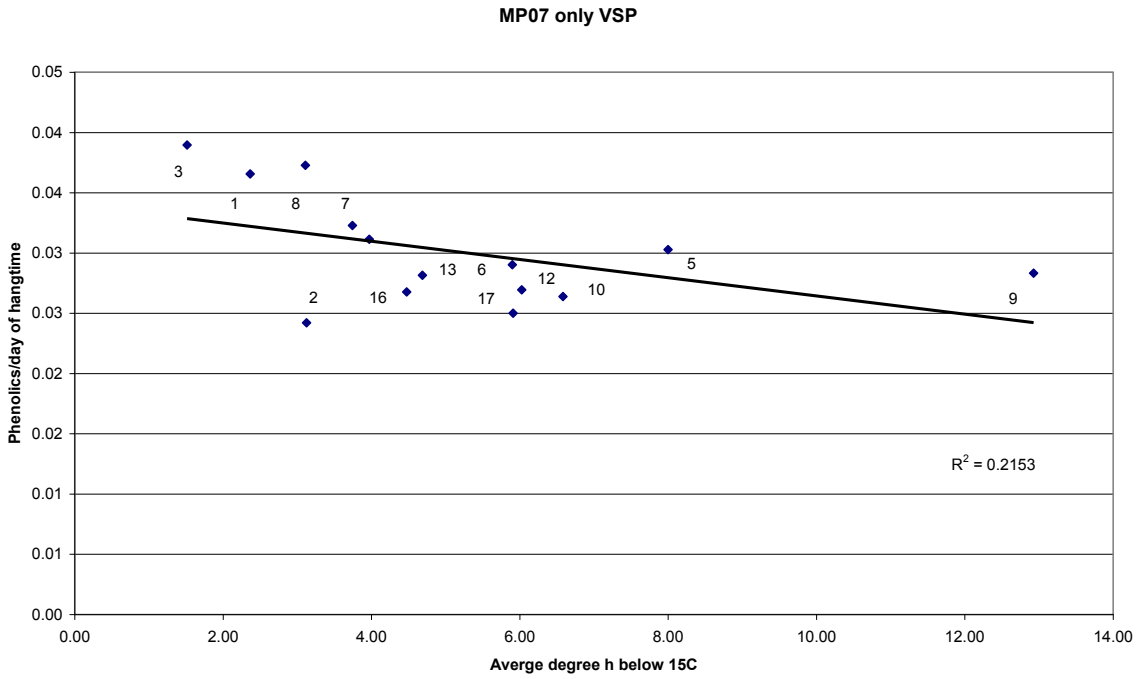


Fig. 37: Average of 0.8 leaf layers to the N ad W of the bunchzones at veraison showed a trend to more phenolics/day of hangtime compared to more dense foliage – hopefully they are ripe skin phenolics

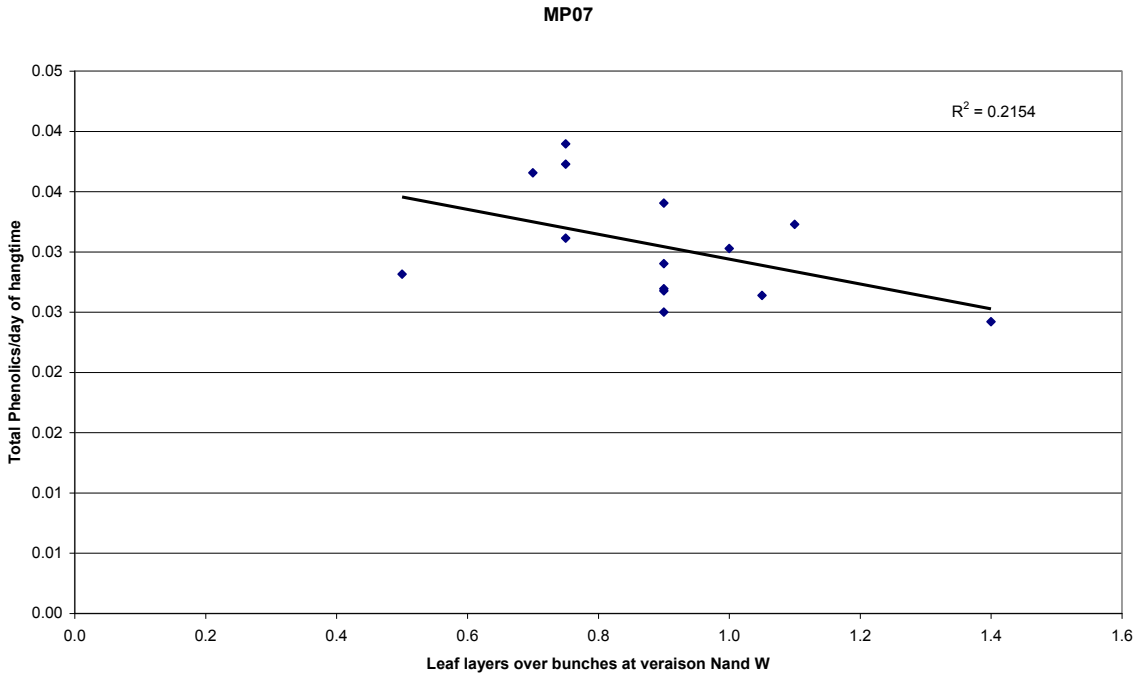


Fig. 38: Plucking to less than on average 0.6 layers on the E and S side had no positive effect on total phenolics.

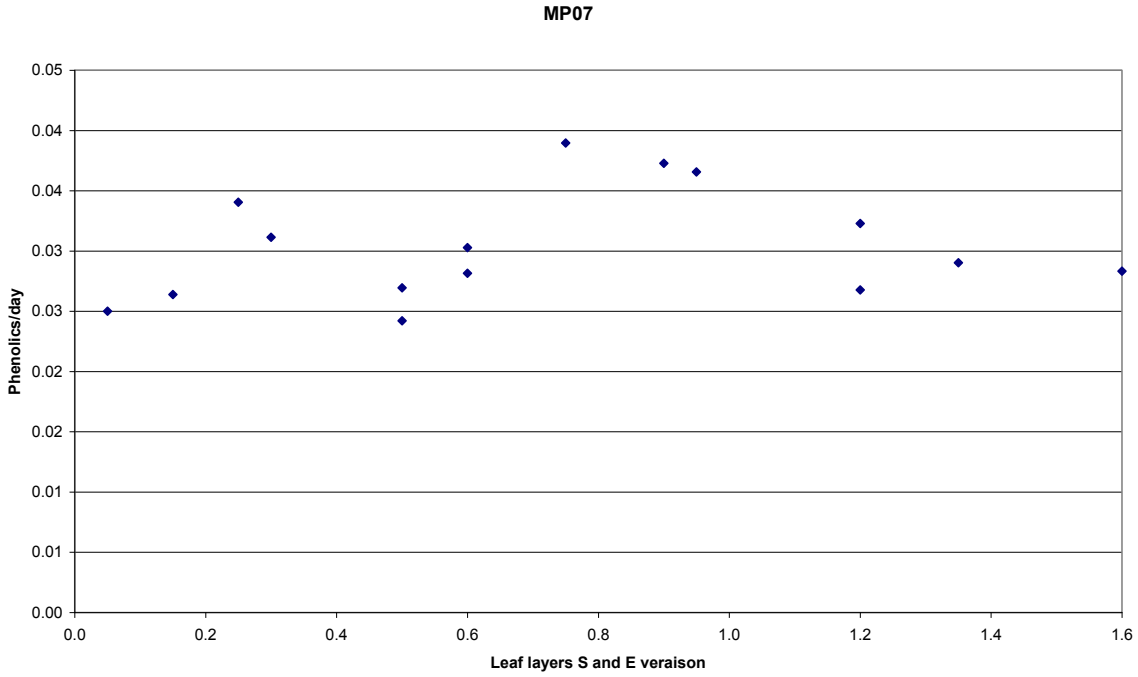


Fig. 39: Long hangtimes can produce higher phenolics.

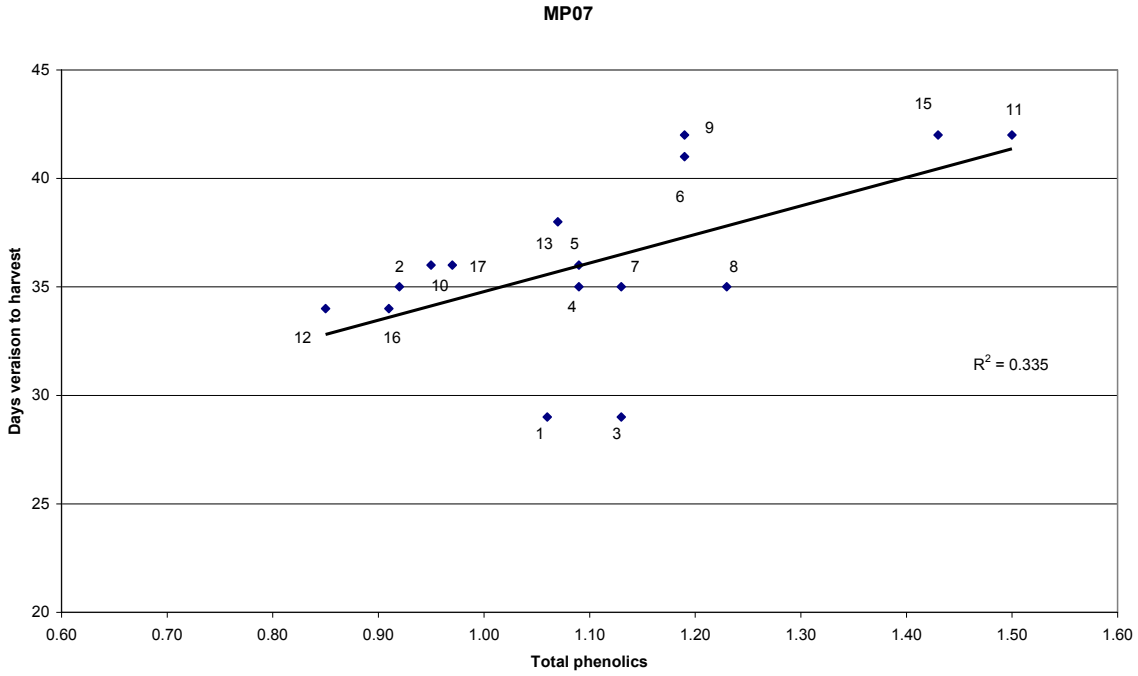
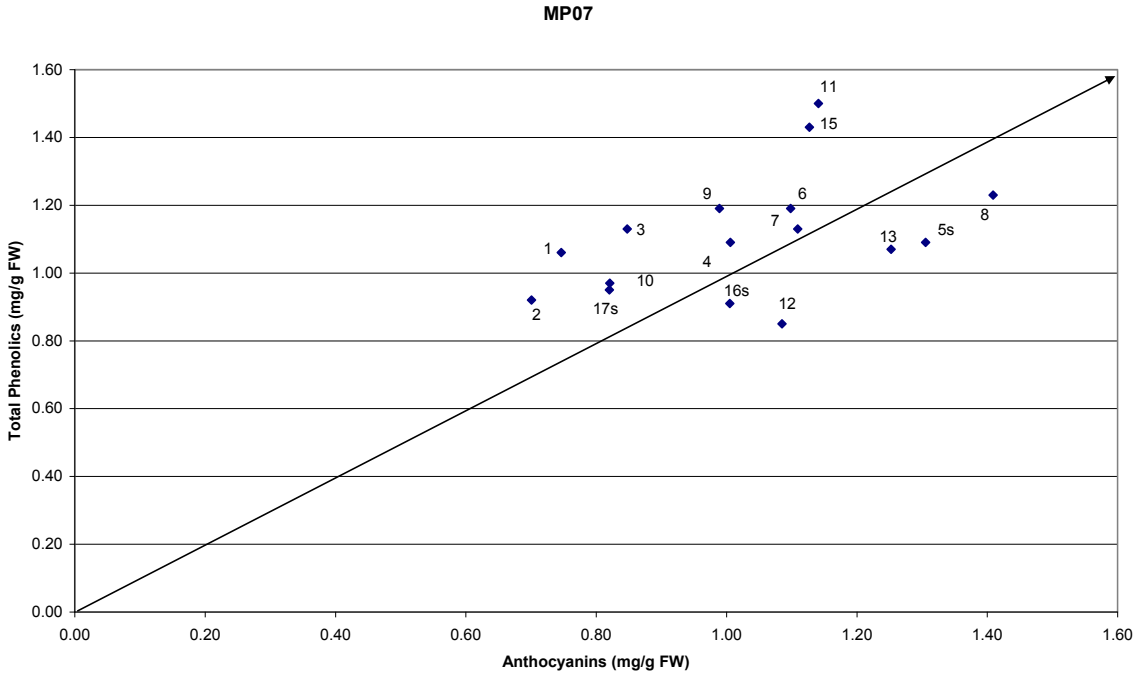


Fig. 40: In 07 anthocyanin concentration in grapes again spanned a wide range (0.7-1.4) with total phenolics between 0.85 and 1.5 (values last year were calculated differently). Higher colour came from slightly shaded cooler (or in 1 case shrivelled) grapes which normally do not excel in total phenolics. Some grapes which had more phenolics than anthocyanins came from warmer vineyards or longer hangtimes.



Flavonols

Fig. 41: Flavonol concentrations tended to be higher from bunches with lower leaf layers in the N and W at veraison (leaf layers E and S did not show any trend of an effect on flavonols).

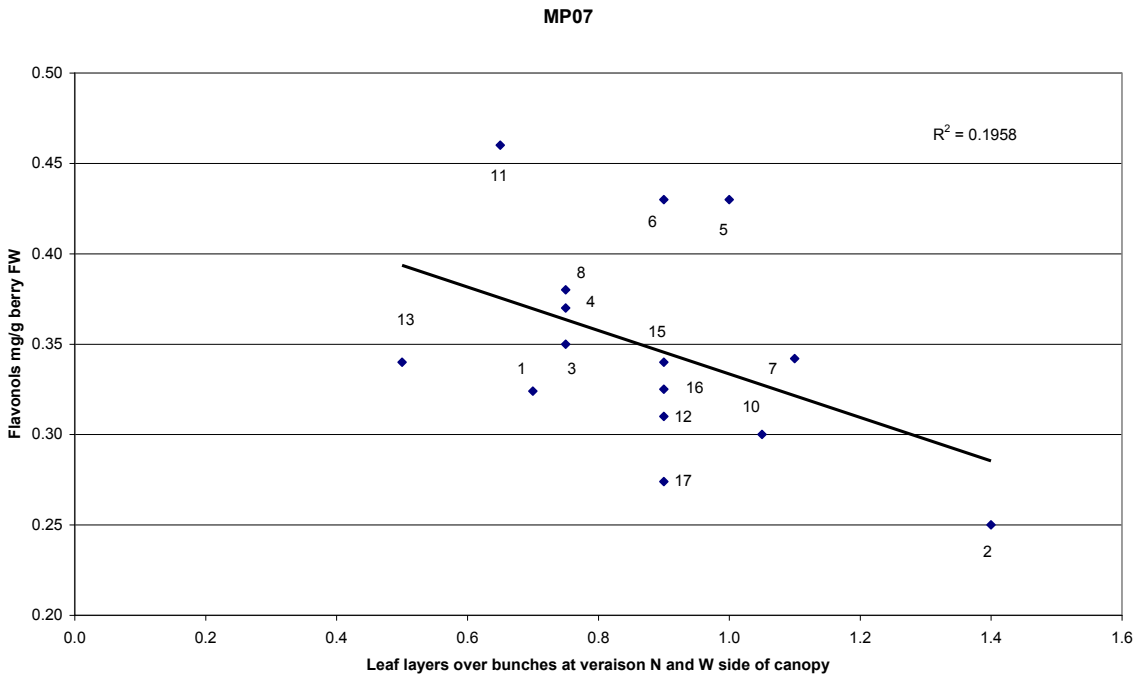
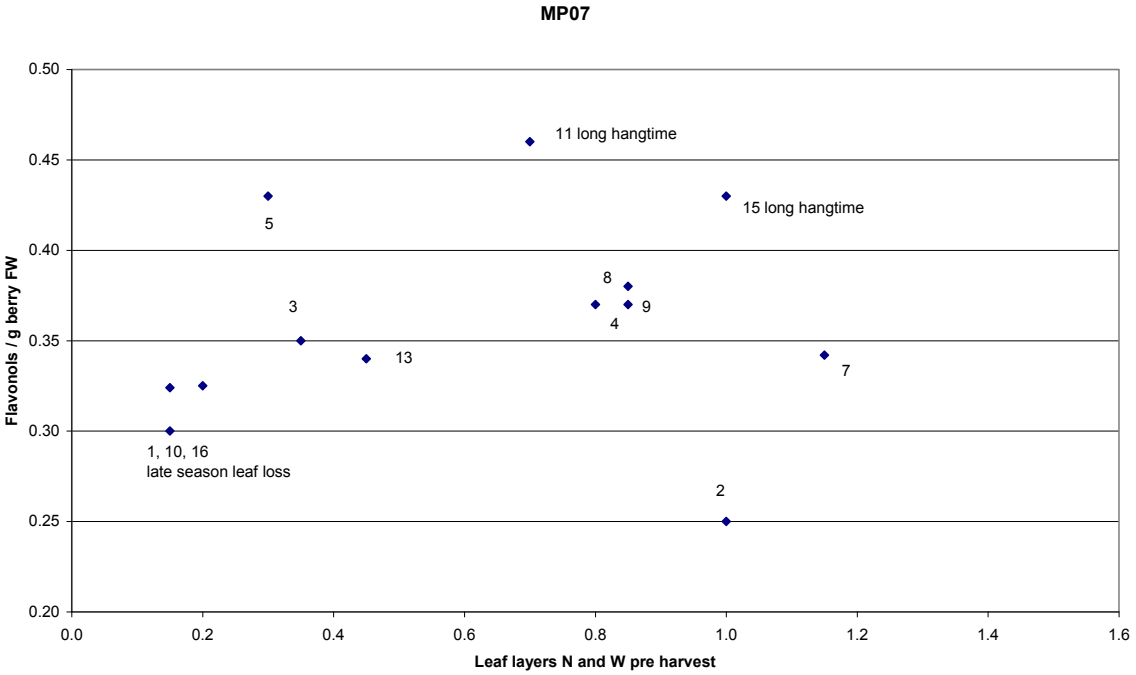


Fig. 42: Leaf layers N and W were low at the end of the season in some vineyards due to desiccation and drought or plucking and leaf layers were not correlated any more to flavonols – which is no surprise as they are formed pre veraison.





Berry Sensory Assessment

Berry sensory assessment showed that picking decisions may have been made due to the loss of acid, not the BSA rating – or earlier picking was expected to bring more interesting aromas in the wine.

Fig. 43a: Berry BSA results for 17 MP vineyards pre harvest 07 showing hardly any ratings above 3.

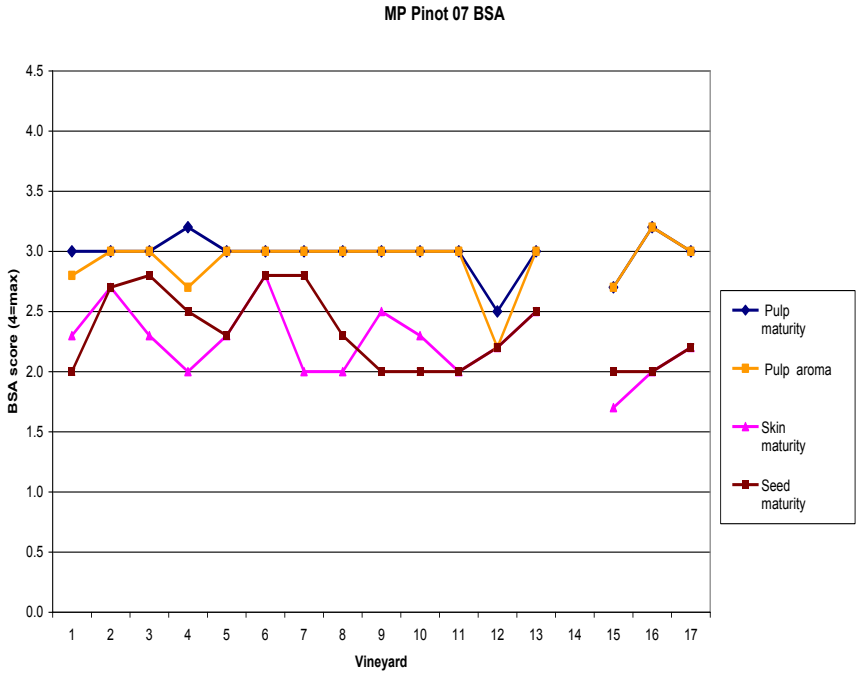


Fig. 43b: Berry BSA results for 22 Mornington P. vineyards pre harvest 06

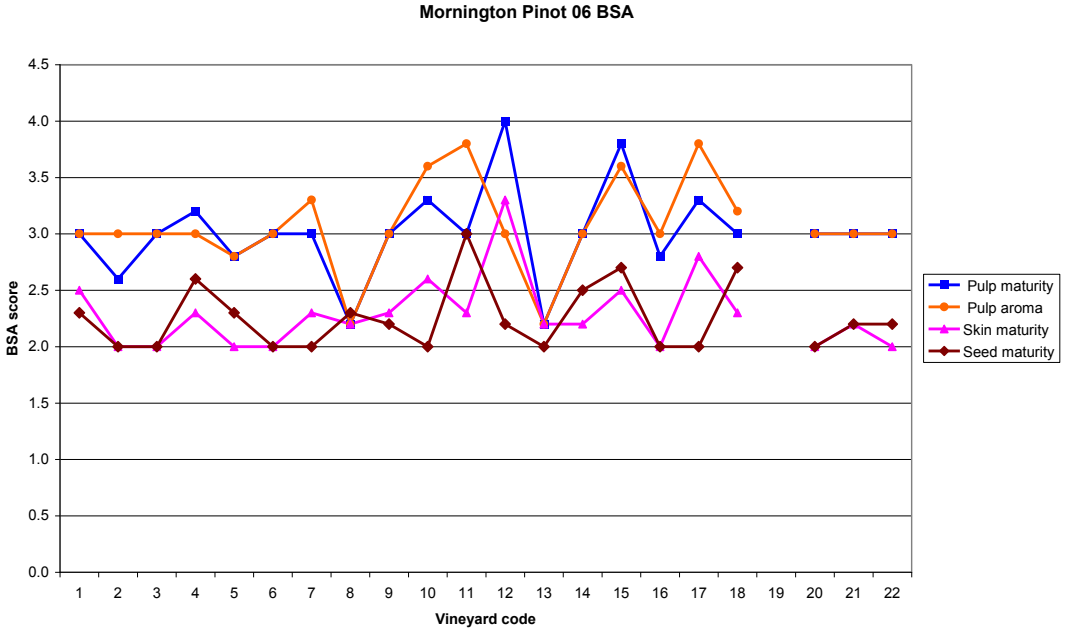
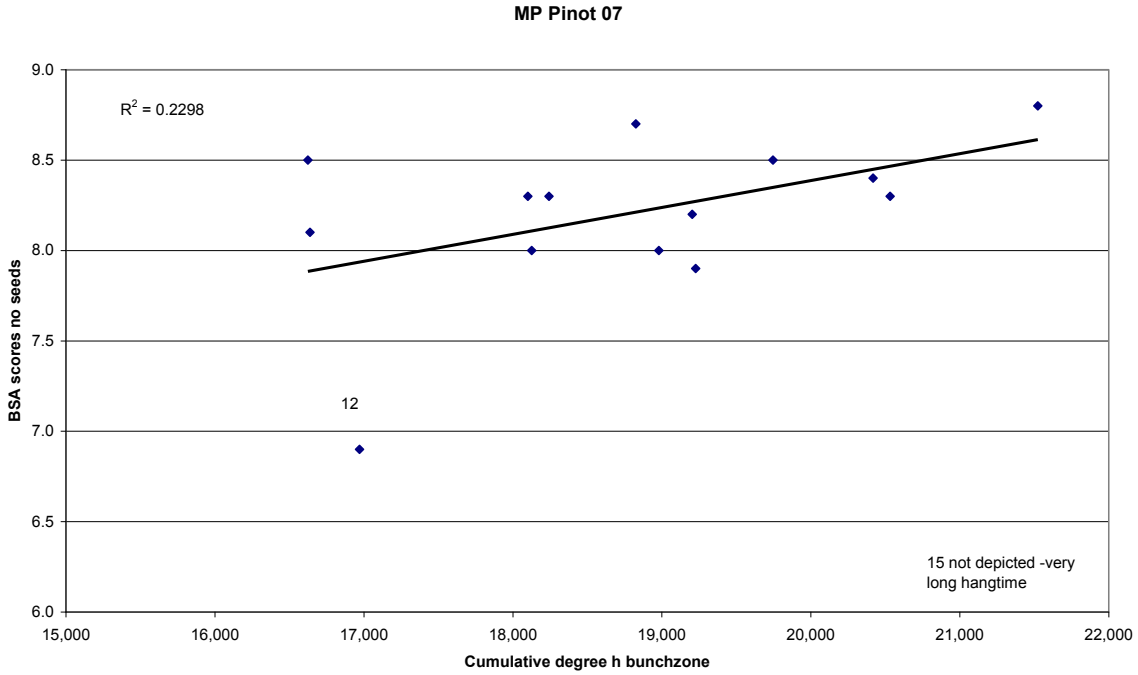


Fig. 44 a,b In 07 BSA scores without seeds showed a weak trend that more cumulative degree hours veraison to harvest received better scores, all being between 15,000 and 22,000 (except M15 with long hangtimes and 25,000 not depicted) which did not result in high BSA scores.



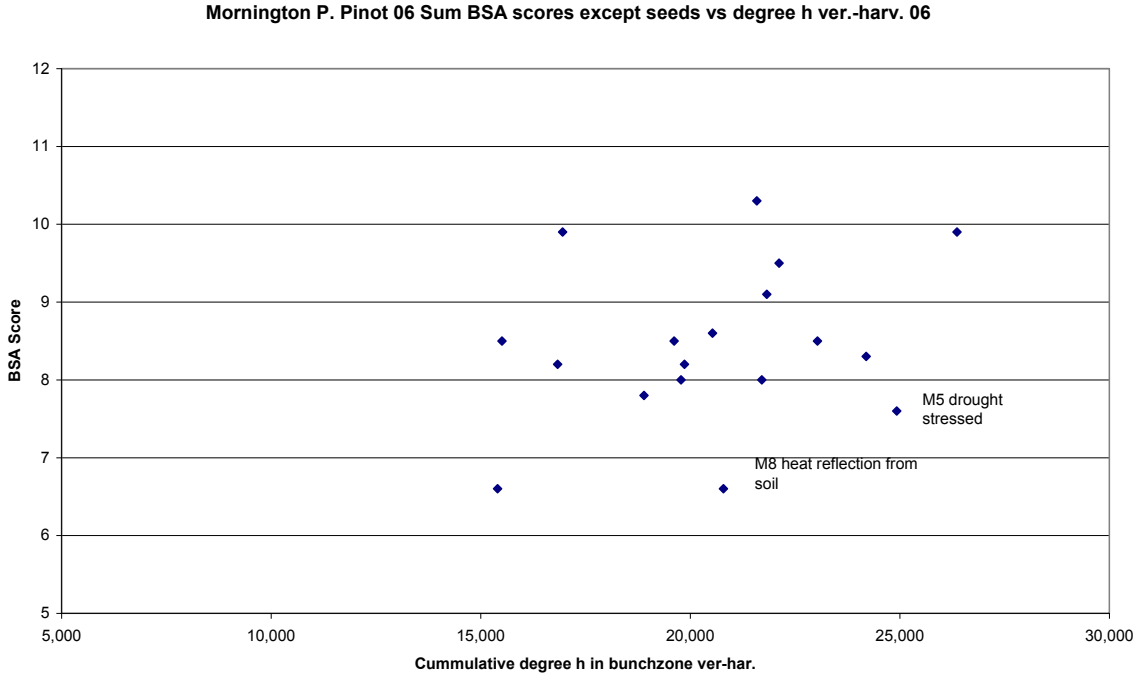


Fig. 45: BSA scores had a trend to be better at higher exposure to the N and W and or longer hangtime. Warmer bunchzones lead to better BSA scores but lower colour.

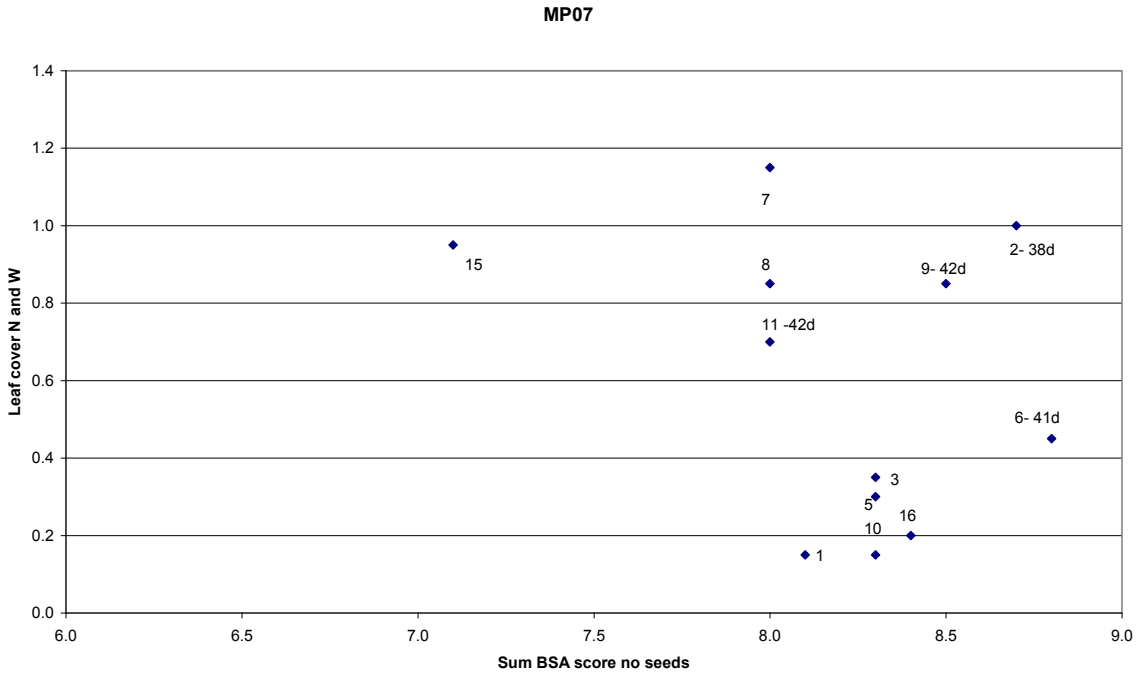


Fig. 46: There was a slight tendency that sugar riper berries will get better BSA scores (no seeds).

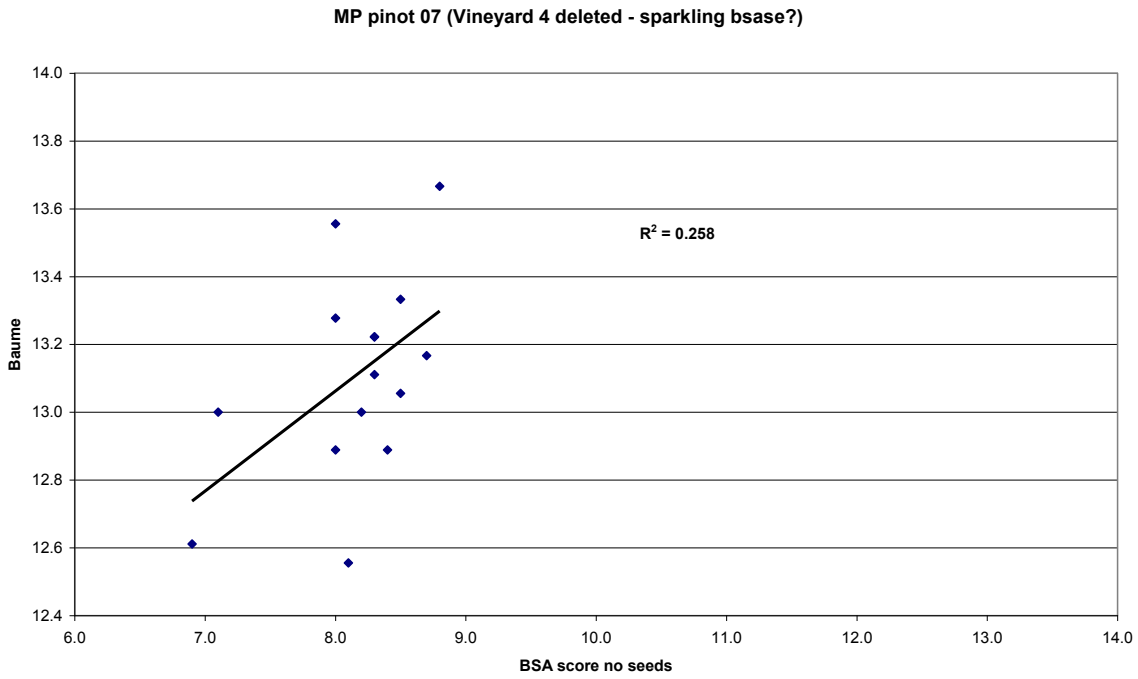


Fig. 47: Seed maturity correlated with the degree of cane lignification at veraison. Cane lignification is a function of the timing and amount of the ripening hormone ABA.

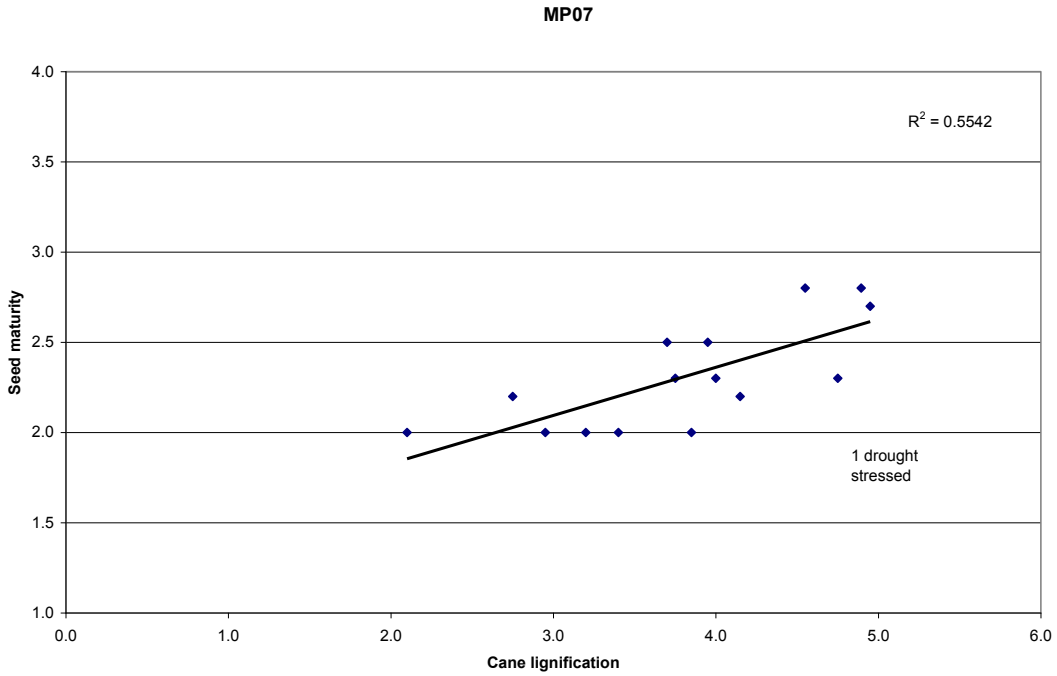
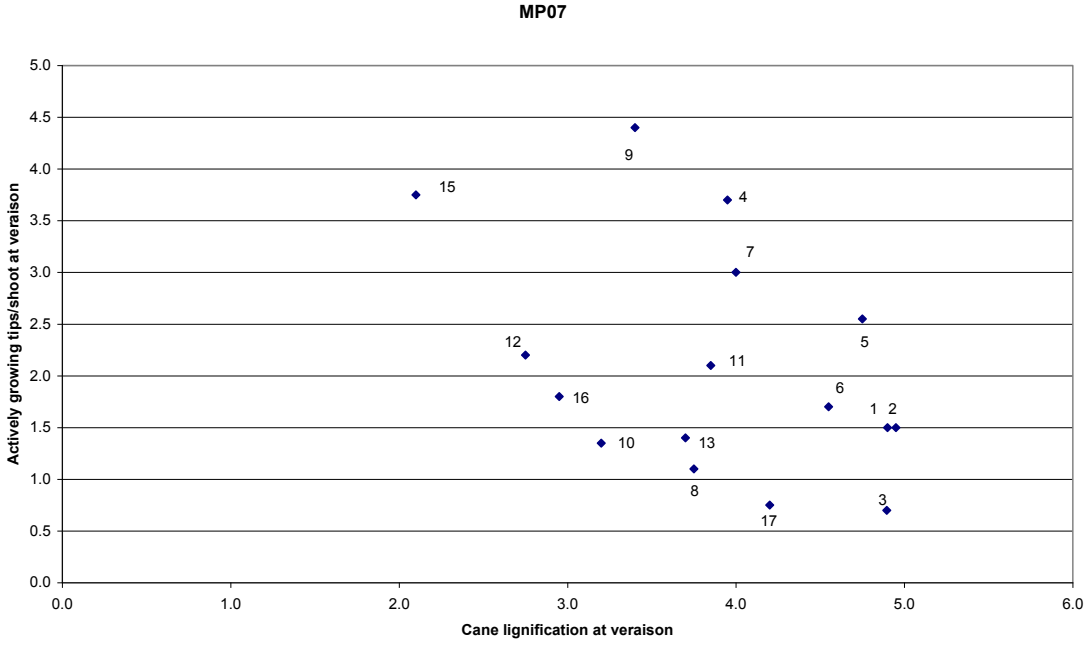


Fig. 48: Highly lignified canes had very few growing shoot tips at veraison and were also associated with late season drought stressed vineyards (drought increases ABA)



Wine assessments

In the correlations as depicted below, wines 2 and 12 were not included as they were later judged and by one judge only.

Fig. 49: The winemakers tasting the sample wines





Wine and BSA

Fig. 50: with a few exceptions BSA could this year predict tannin quantity but not tannin quality, bitterness fruitiness or complexity in wine.

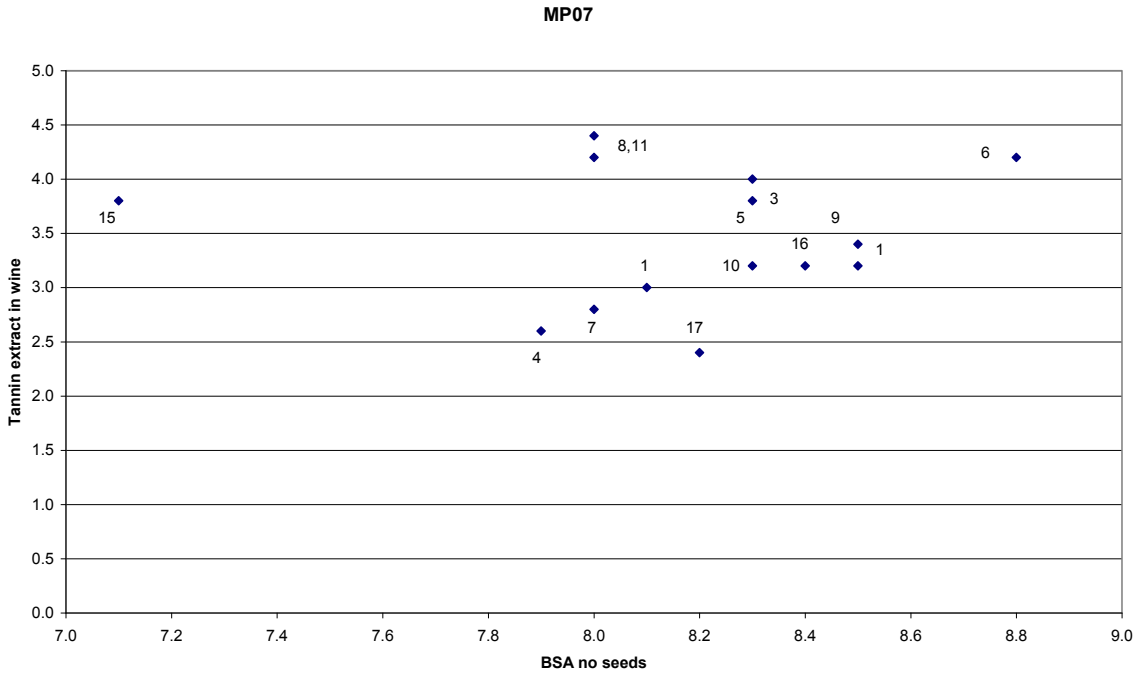
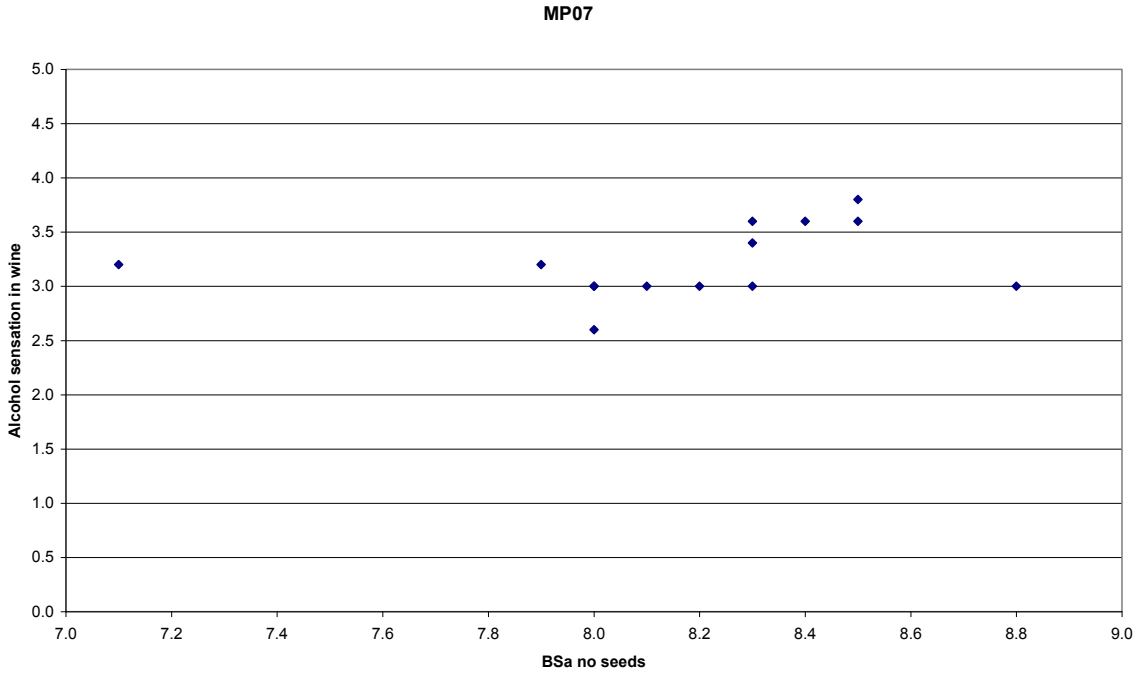


Fig. 51: With 2 exceptions higher BSA ratings (no seeds) coincided with higher alcohol sensation in wine.



Wine judgements and vineyard assessments

Fig. 52a: Wines with scores above 15.5 had more than 2000 cm^2 of active leaf per shoot at veraison (except 1 and 3, 4 was harvested under-ripe).

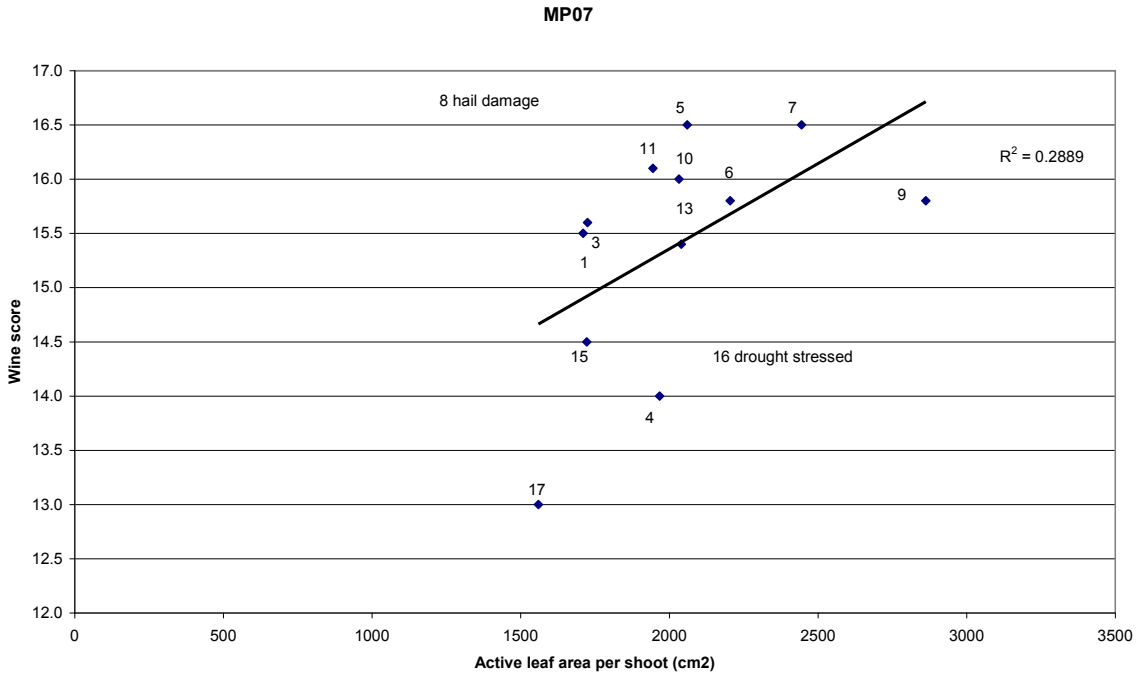


Fig. 52b: In 06 High and moderate wine scores came from 1200 – 1500 cm^2 active leaf area, due to shrivel and other influences.

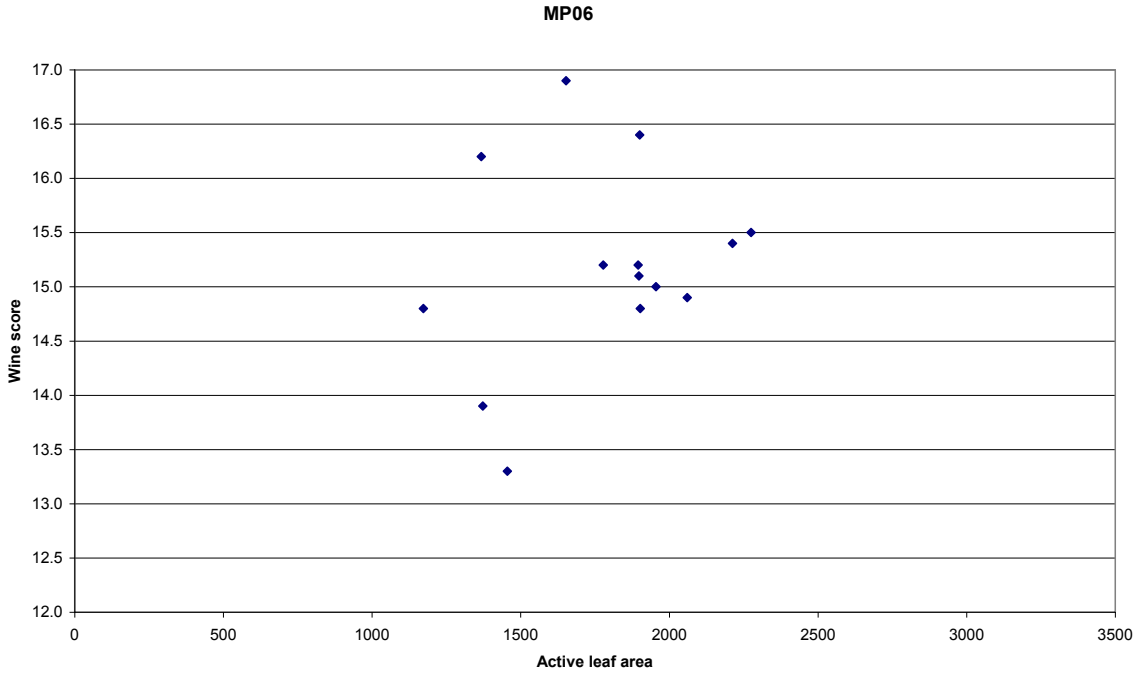


Fig. 53a: In 07 Wines with scores above 15.5 had a moderate vine balance figure (15-25).

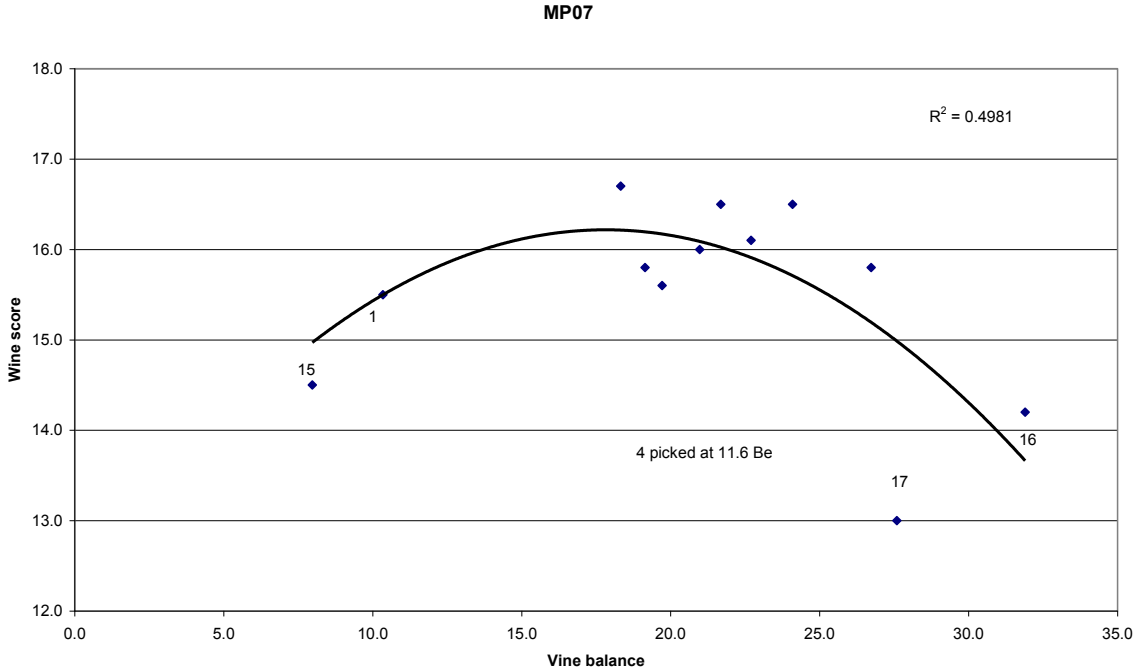


Fig. 53b: In 06 many vines had a low vine balance

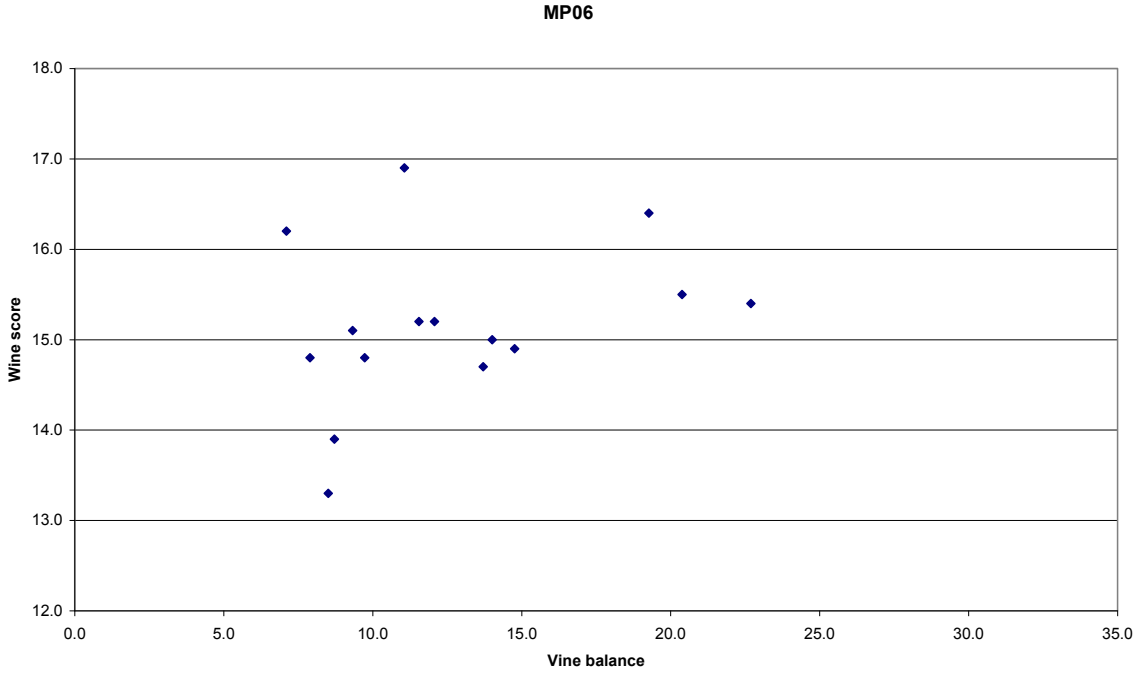


Fig. 54: Low degree of cane lignification may coincide with a potential for low wine scores

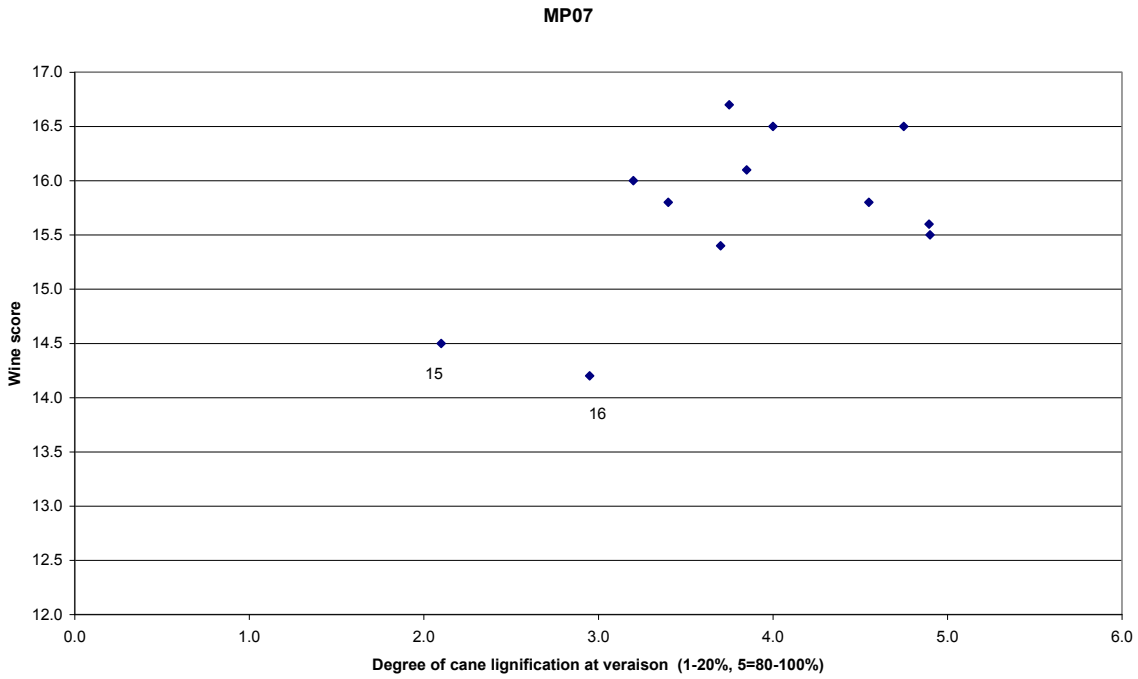


Fig. 55: Low degree of cane lignification slightly correlated with high vegetal flavour in wine (1 has a row of Cyprus trees adjacent to the vineyard).

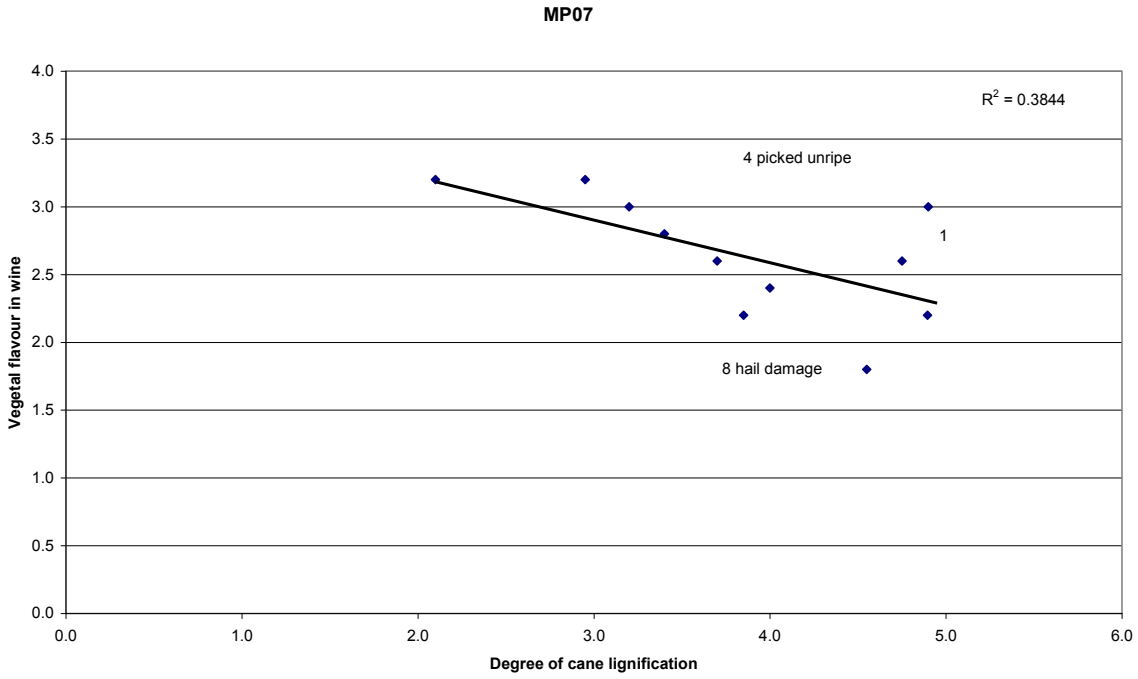


Fig. 56: There was a link between better wine scores and more growing shoot tips at veraison when data from hail damaged vines, those from a non VSP trellis and from an overvigorous vineyard were excluded. This could of course also reflect a link between high drought stress (as indicated by poor leaf condition) and low wine score.

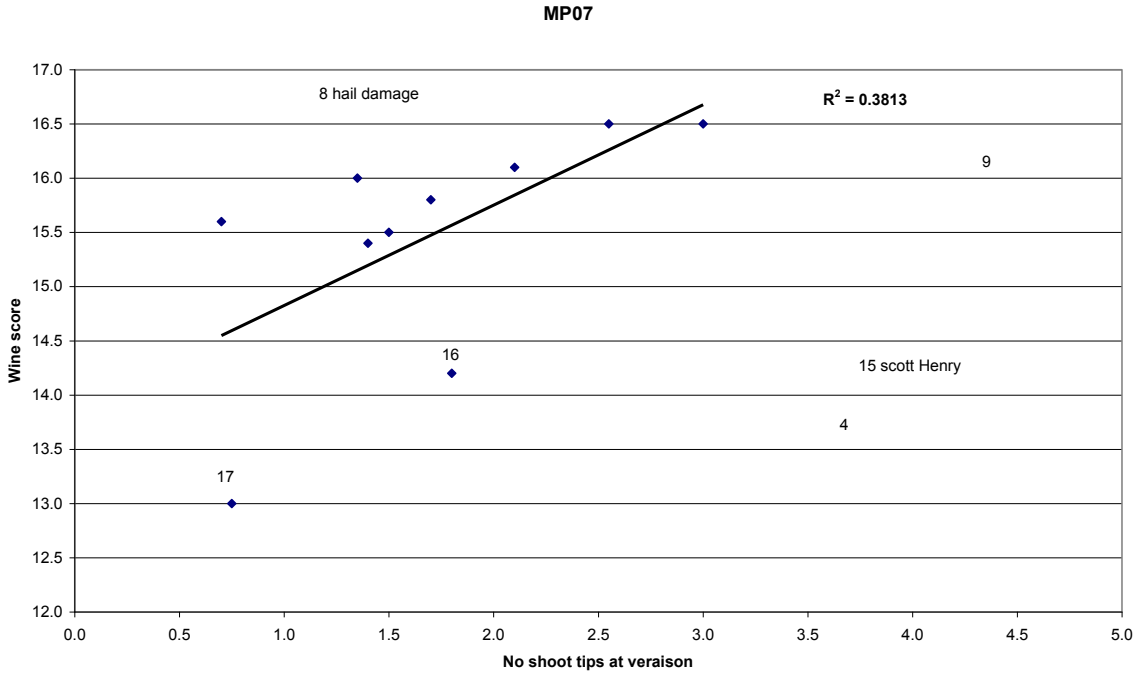


Fig. 57: Vineyard with a large number of growing shoot tips at veraison and high wine quality



Fig. 58a: Wine scores were higher with a higher ratio of young to mature active leaves at veraison (4 and 15 excluded)

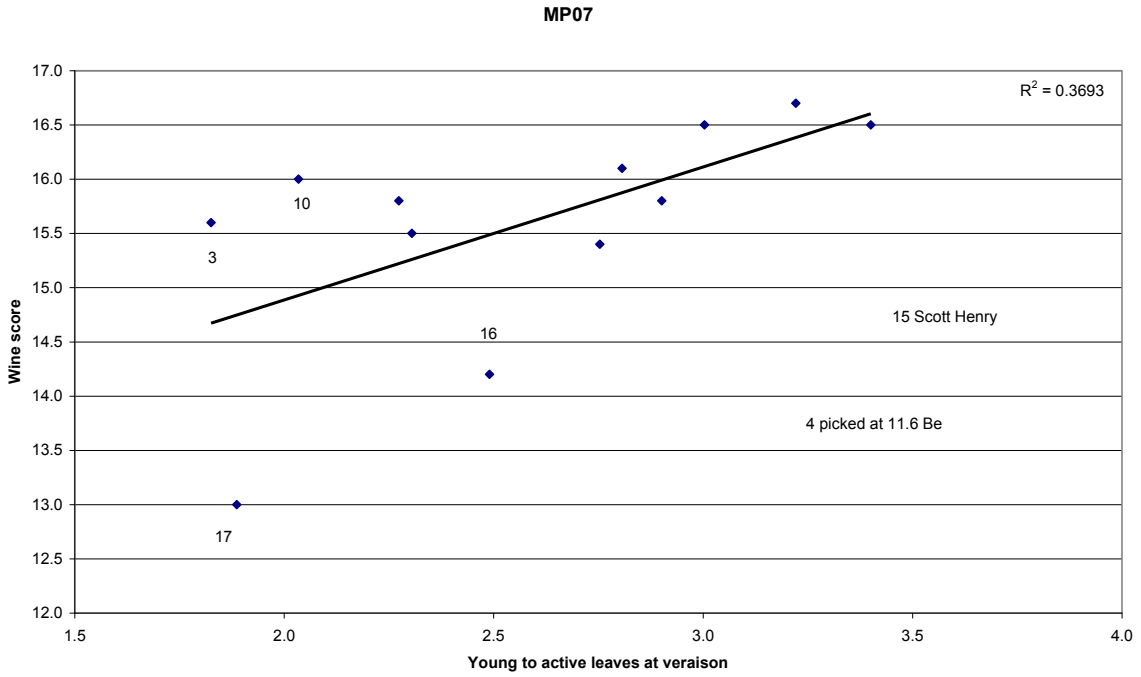
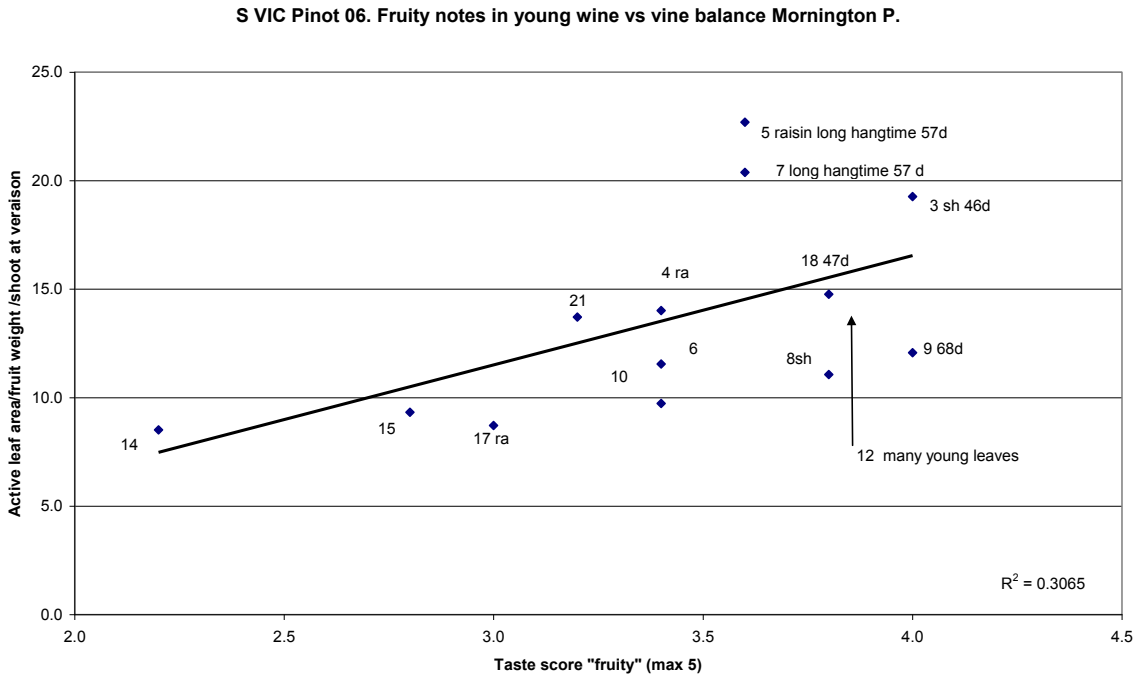
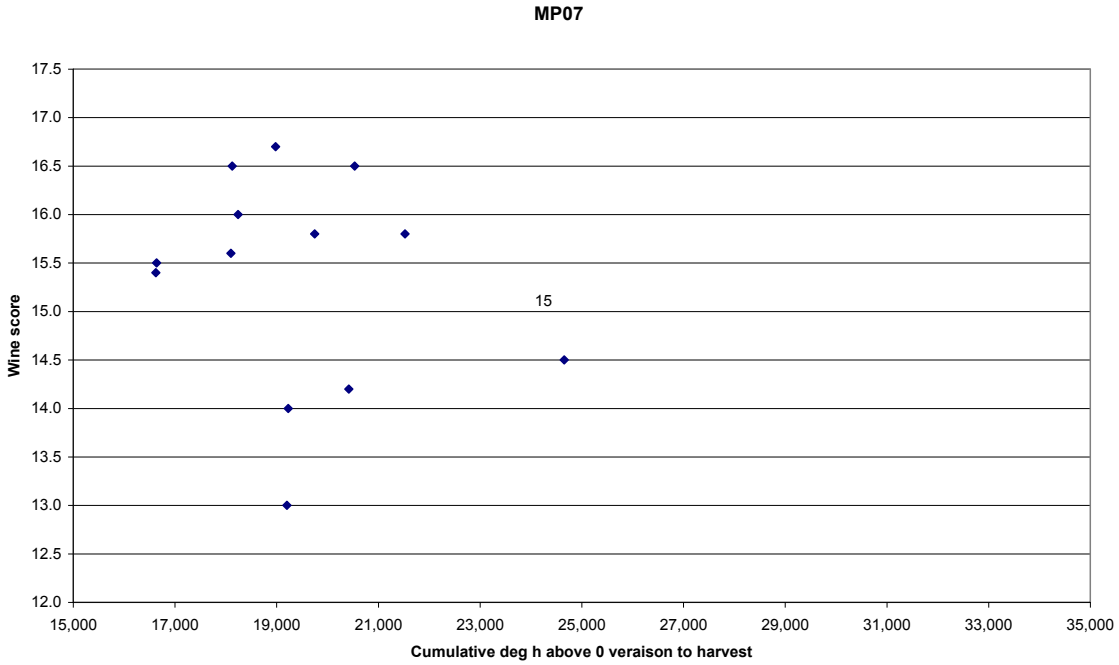


Fig. 58b: Last year best ratio was 10-20.



Wine judgements and bunchzone climates

Fig. 59a, b: Many vineyards had higher wine scores than last year. Cumulative degree hours were less due to shorter hangtimes.



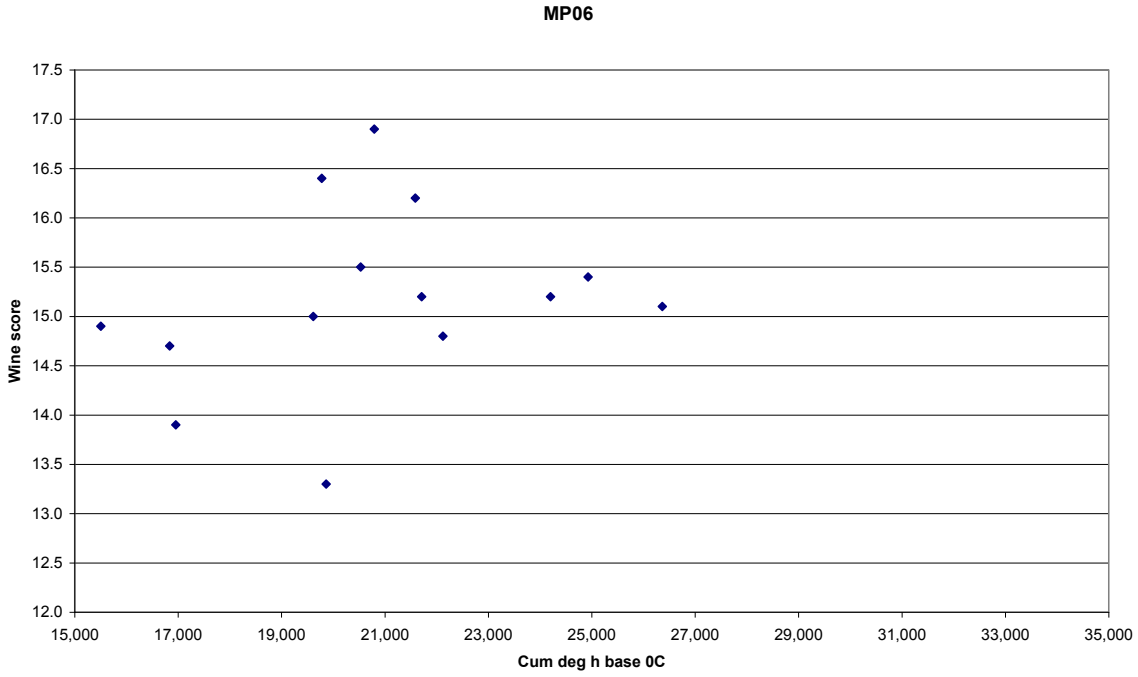


Fig. 60: As a comparison the wine scores and bunchzone temperatures of NE Victorian shiraz in 2005.

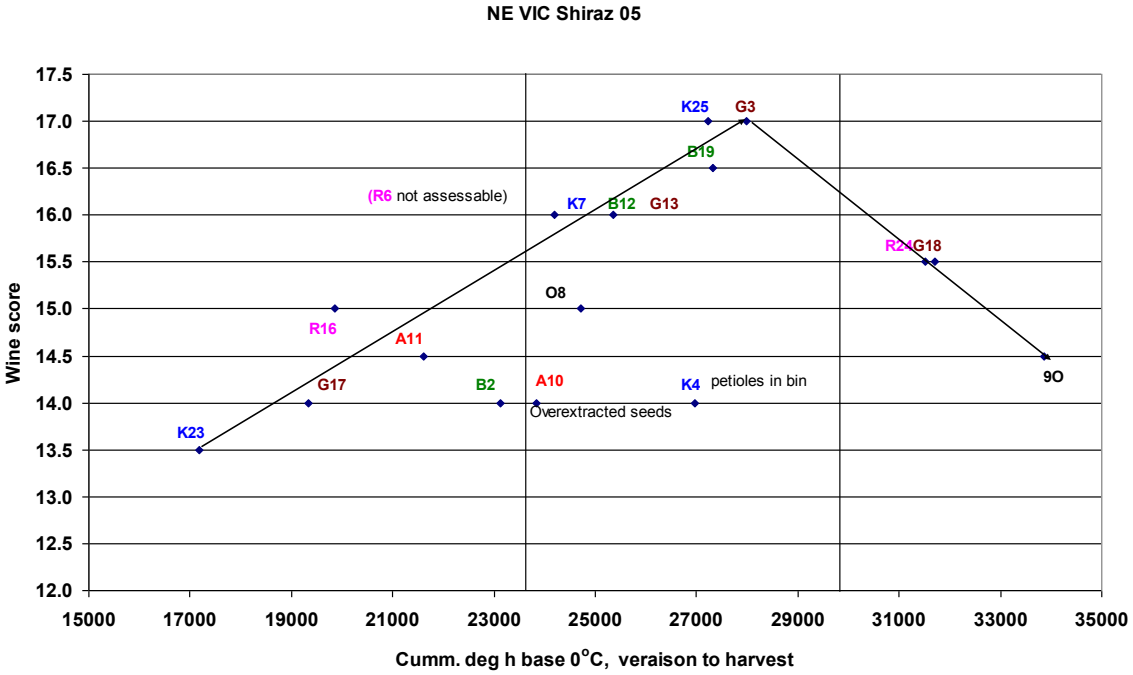


Fig. 61: Bunchzones were warmer this year.

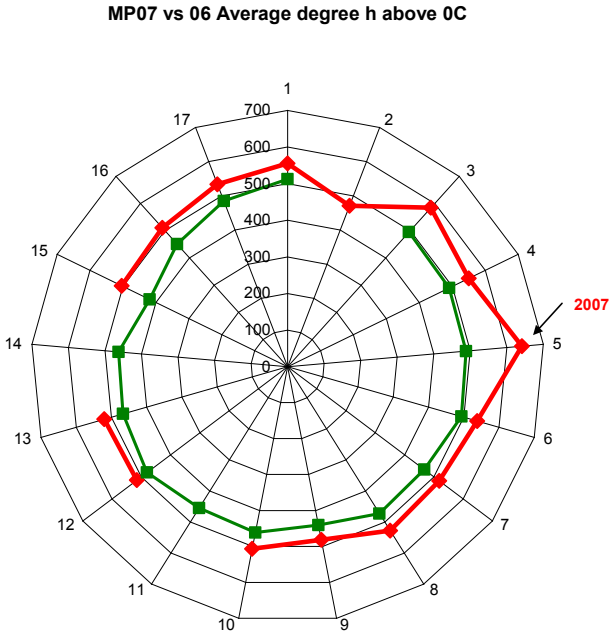
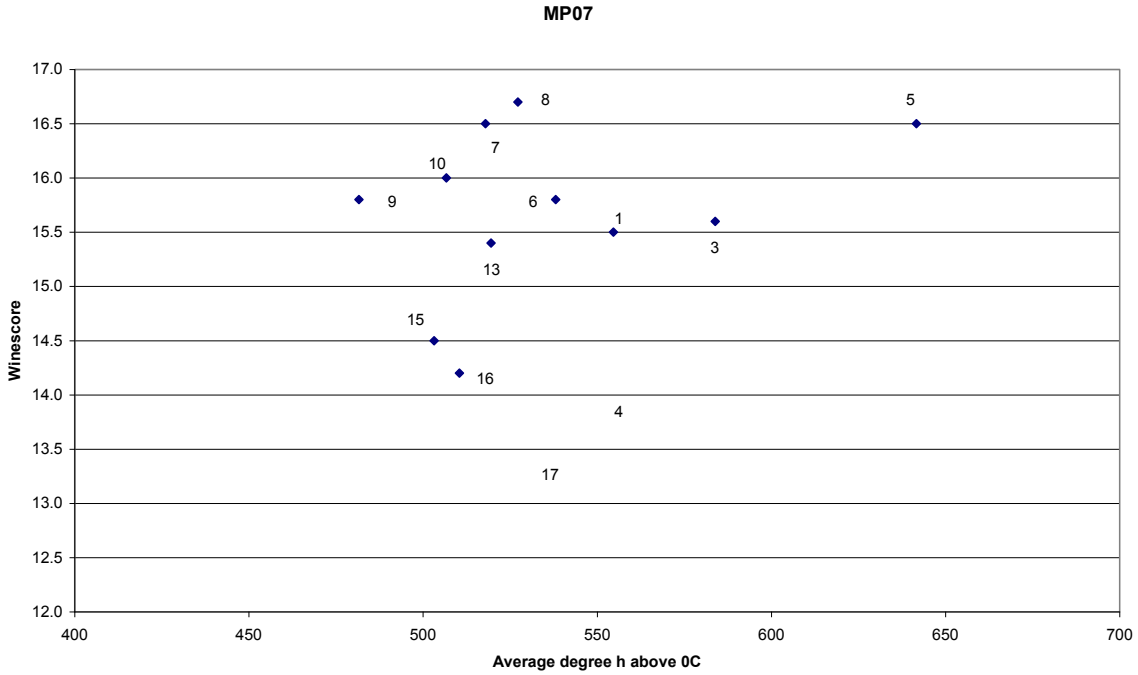


Fig. 62 a,b: Many cases this did result in a better wine score (12 not present)



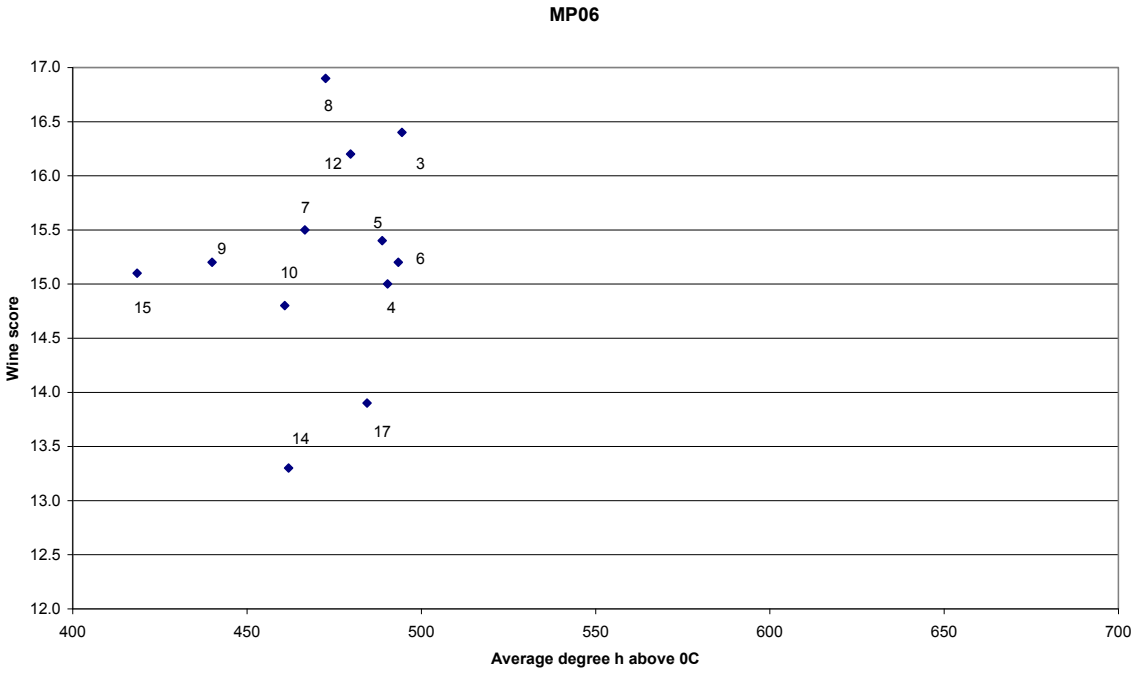


Fig. 63a: Most bunchzones spend a lot of time in the beneficial bracket of 15-26C.

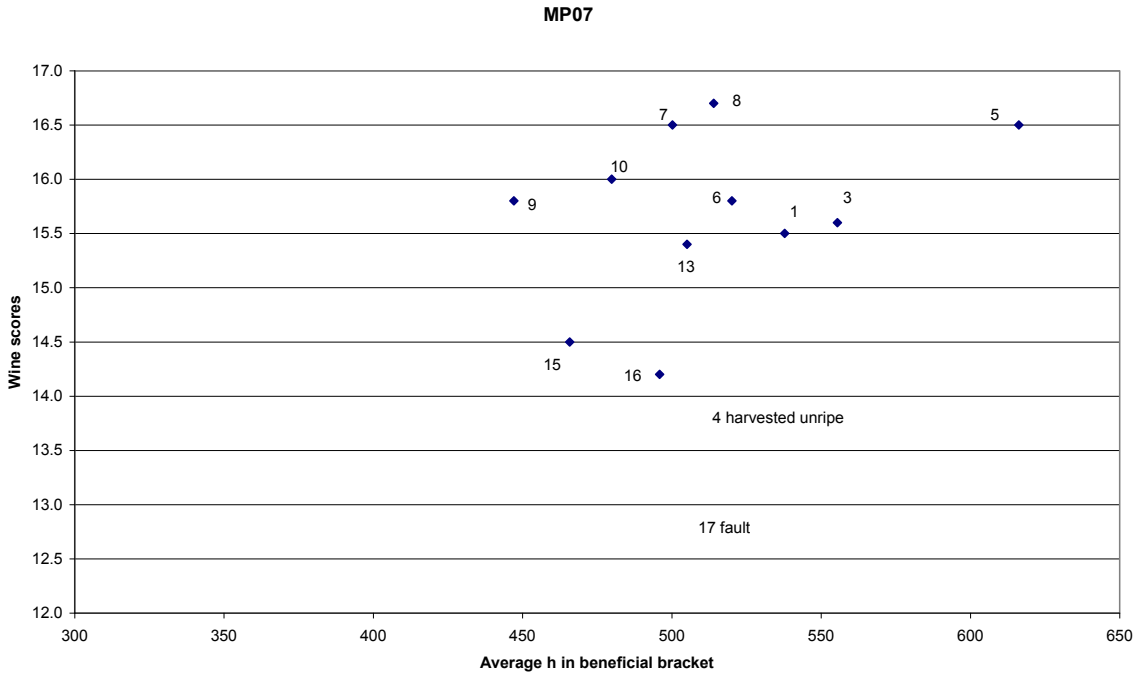


Fig. 63b: More so than last year, where some bunchzones were too cold.

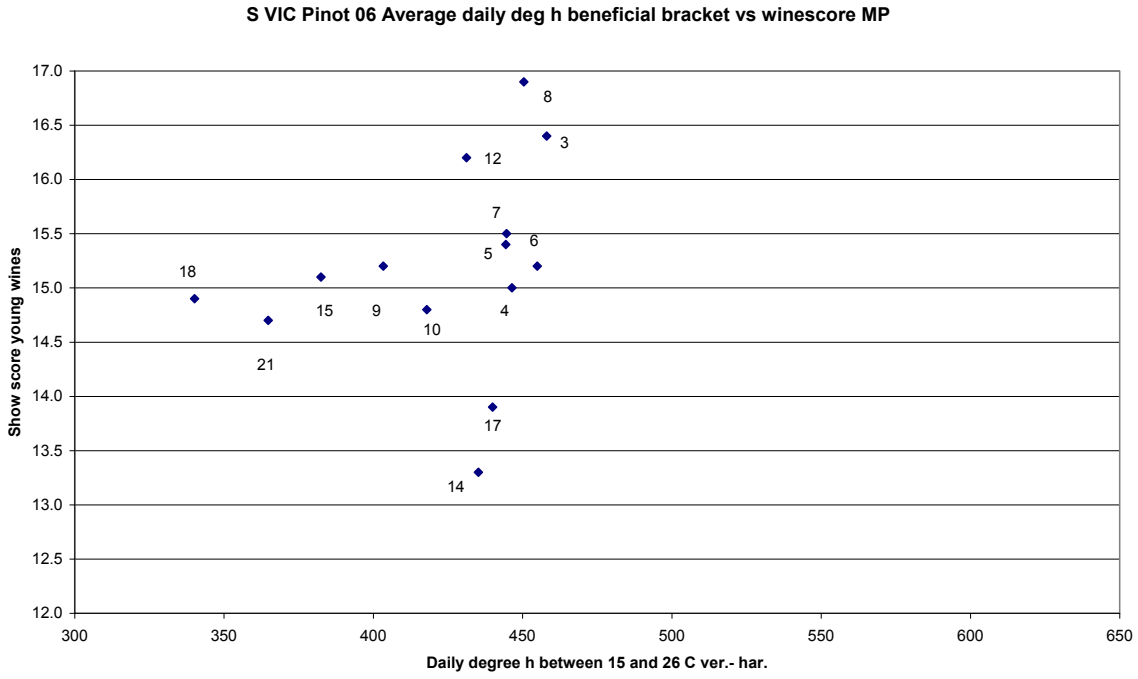


Fig. 64: Various wine scores were obtained from a varied number of heat accumulations.

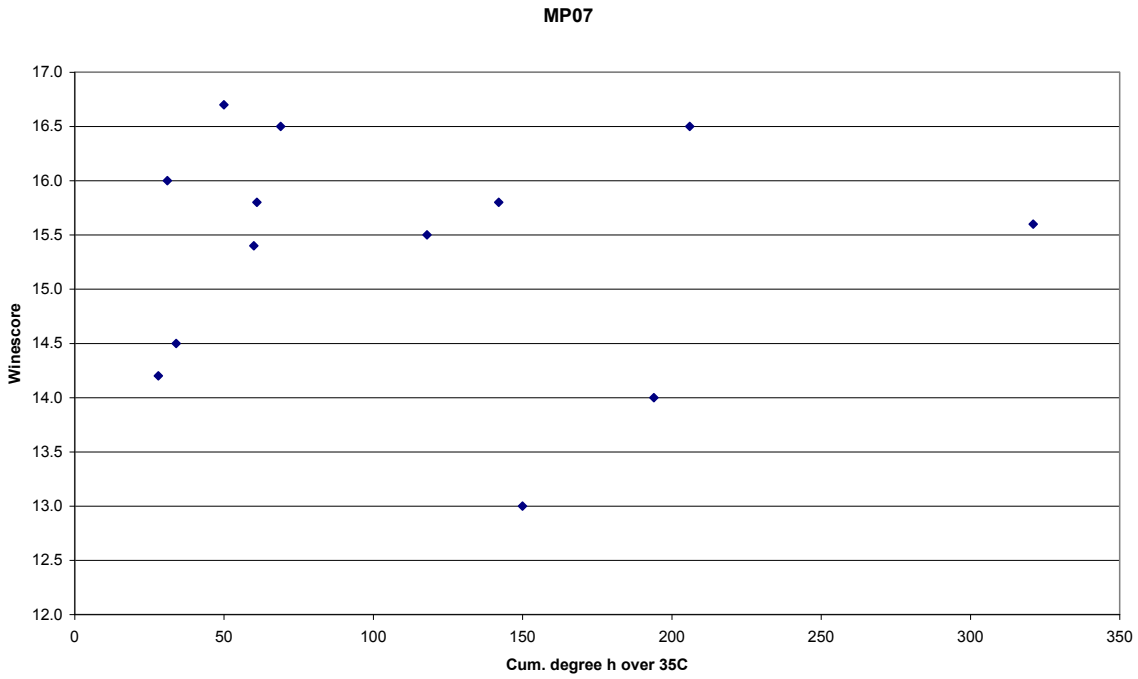
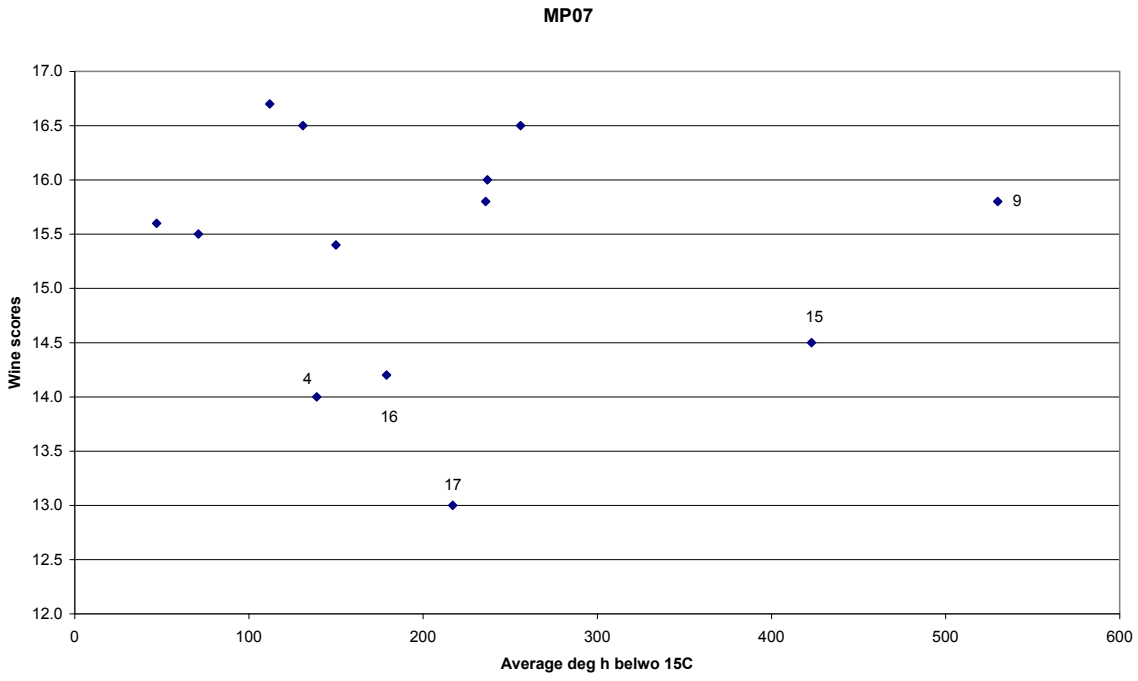


Fig. 65: Average degree h below 15C are not influencing wine scores



Wine judgements and Berry chemistry

Fig 66a: Higher colour in grapes led to higher visual colour in wine (exception 4, 7 and 17 under-extracted and 16 very high)

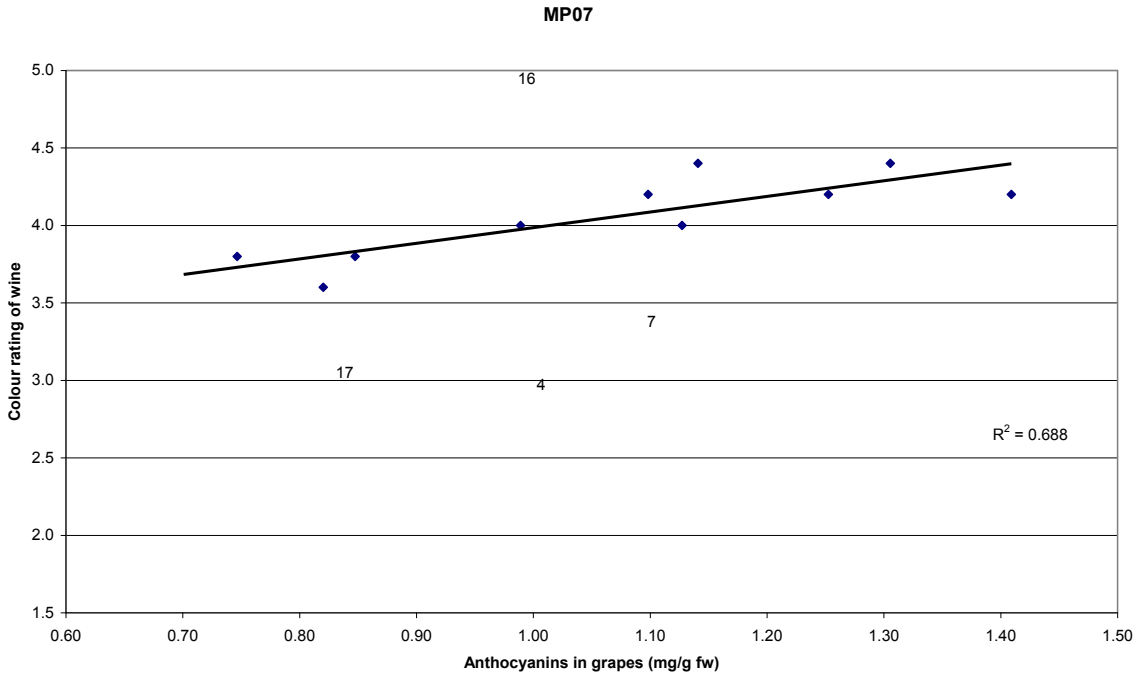


Fig 66b: This relationship was less clear in 06 with more berries having lower colour and more shrivelled berries.

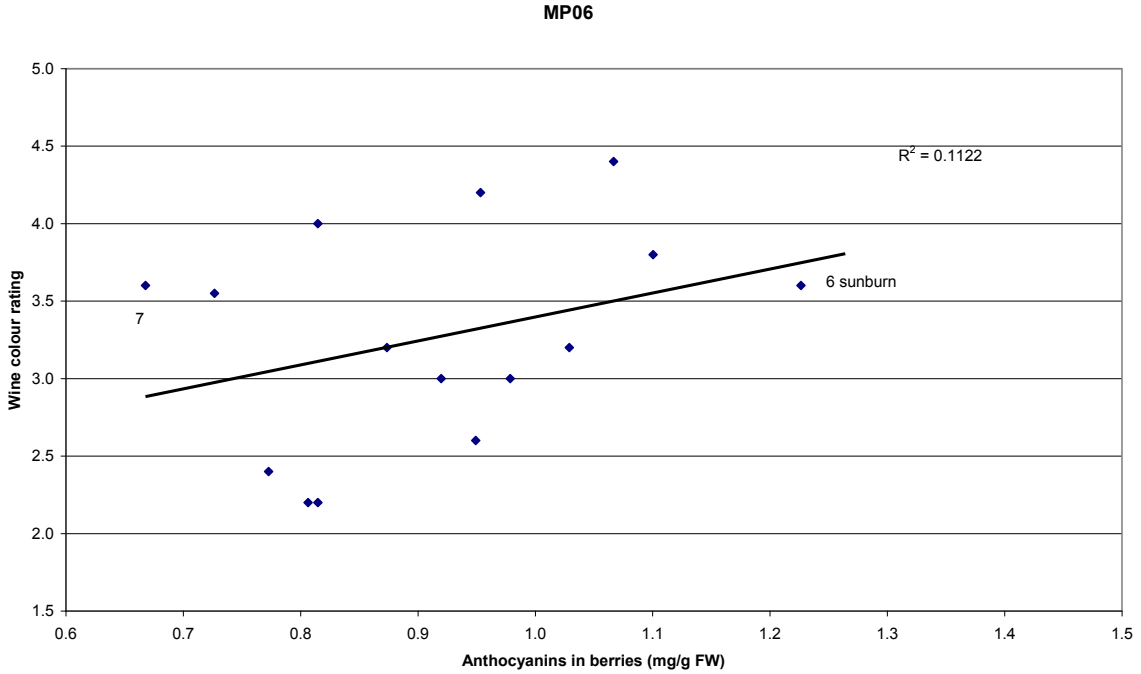


Fig. 67: Colour in the glasses (wines are not sorted by vineyard codes). Fourth wine from left bottom row was over-sulphured in the sample bottle and does not appear in the graphs and tables.



Fig 68: All higher wine scores had riper (>13 Be) grapes (17 had a fault)

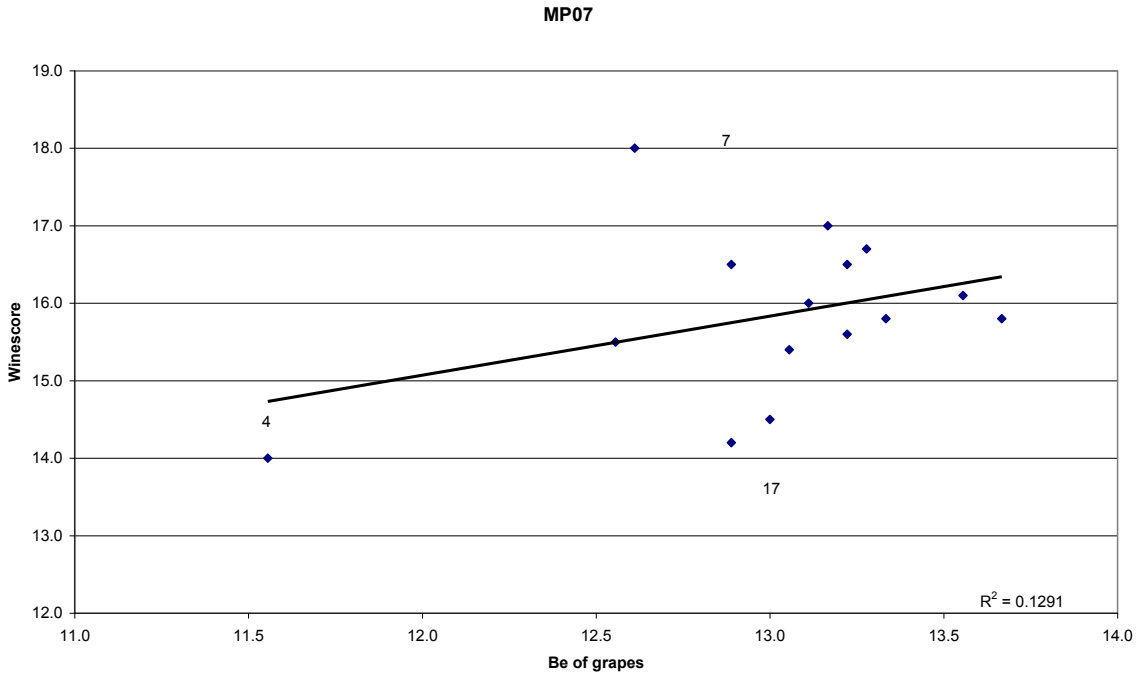


Fig 69: All higher wine scores had higher TA except wine 5 (15 and 17 not in statistics)

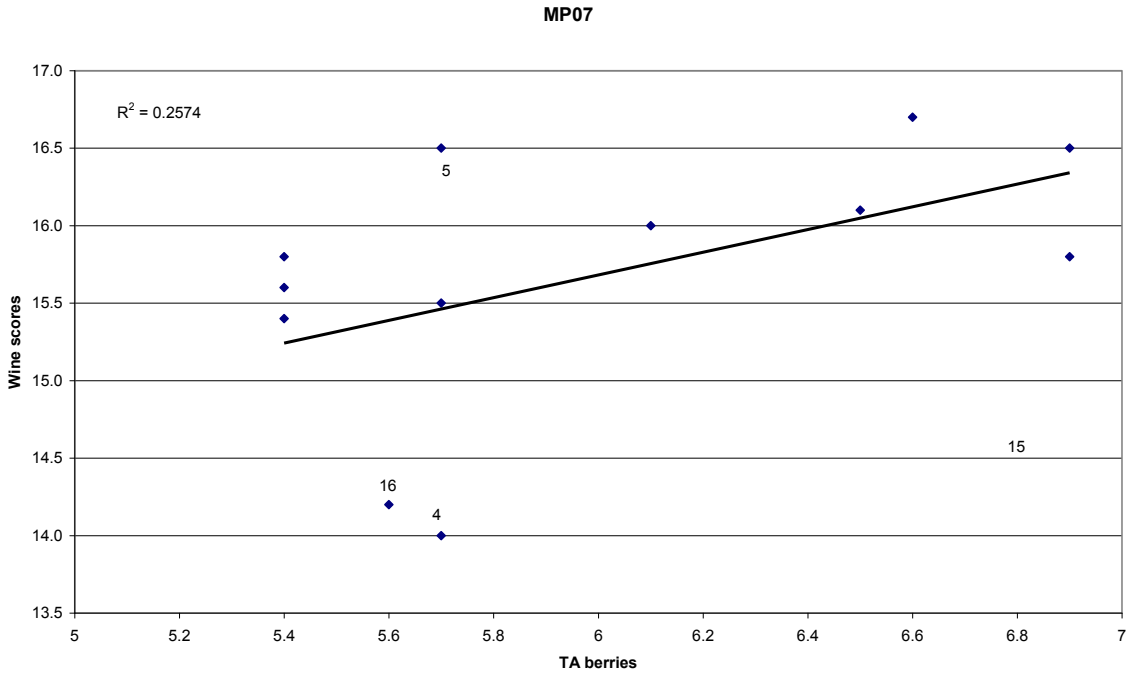


Fig 70: Higher or longer grape exposure (high flavonols) may make better wine (except wines 4 under ripe, and 15 =Scott Henry)

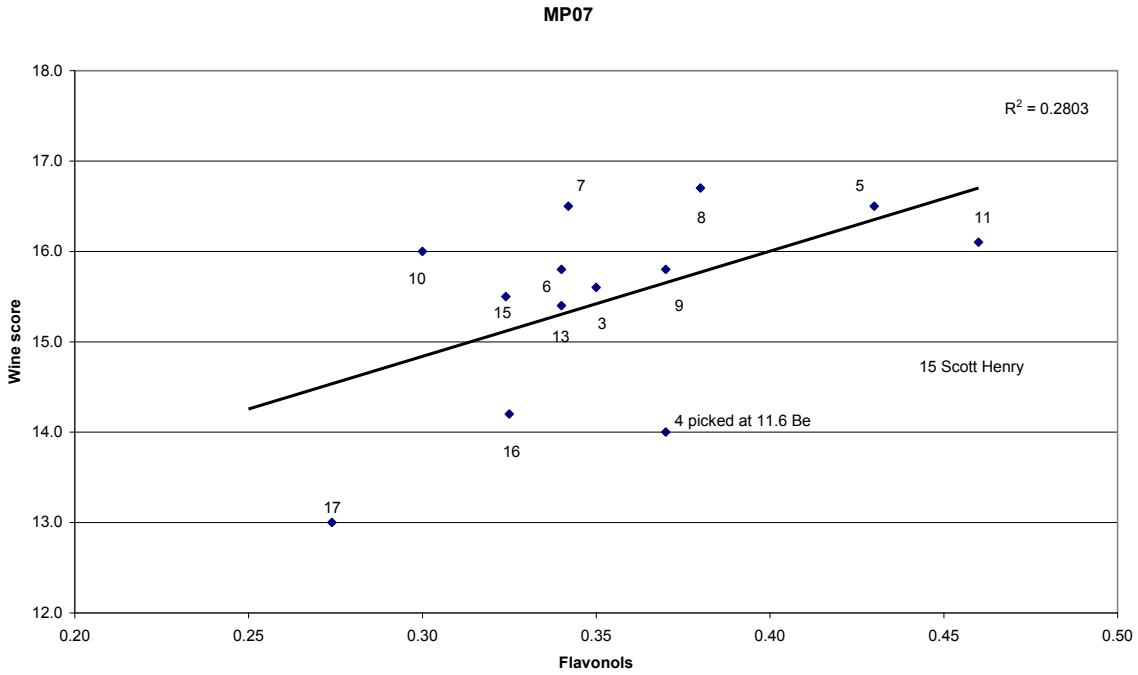


Fig 71a: This year more wines had better colour – visual colour was still important for wine judges

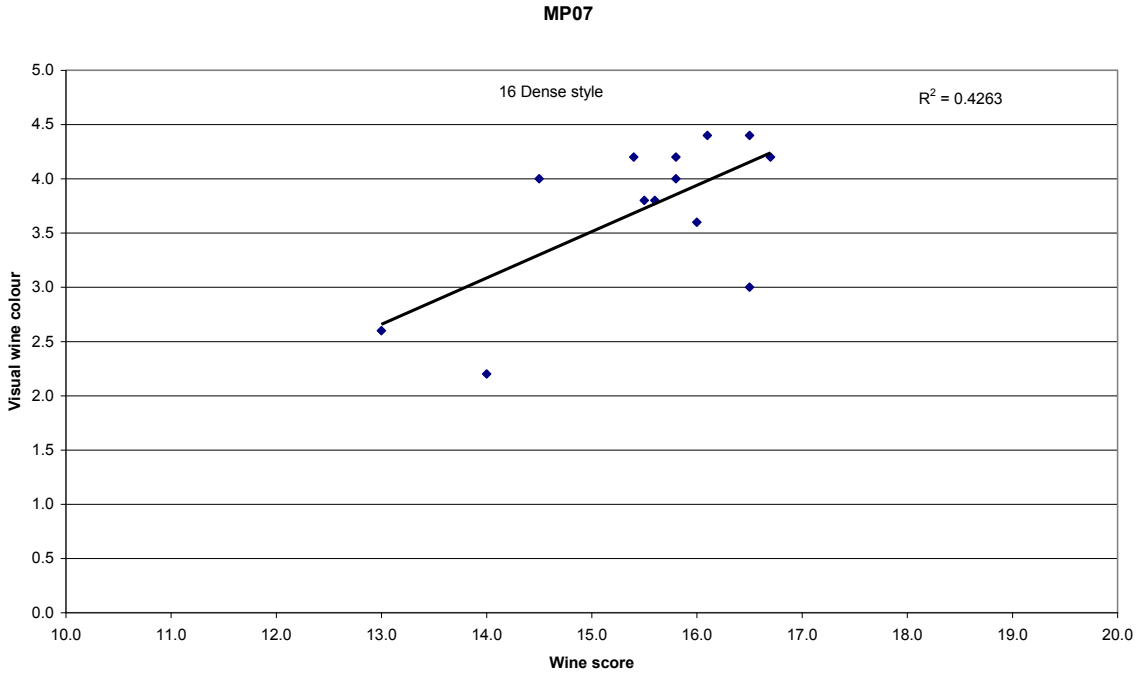


Fig 71b: Last year– visual colour was highly correlated to wine score

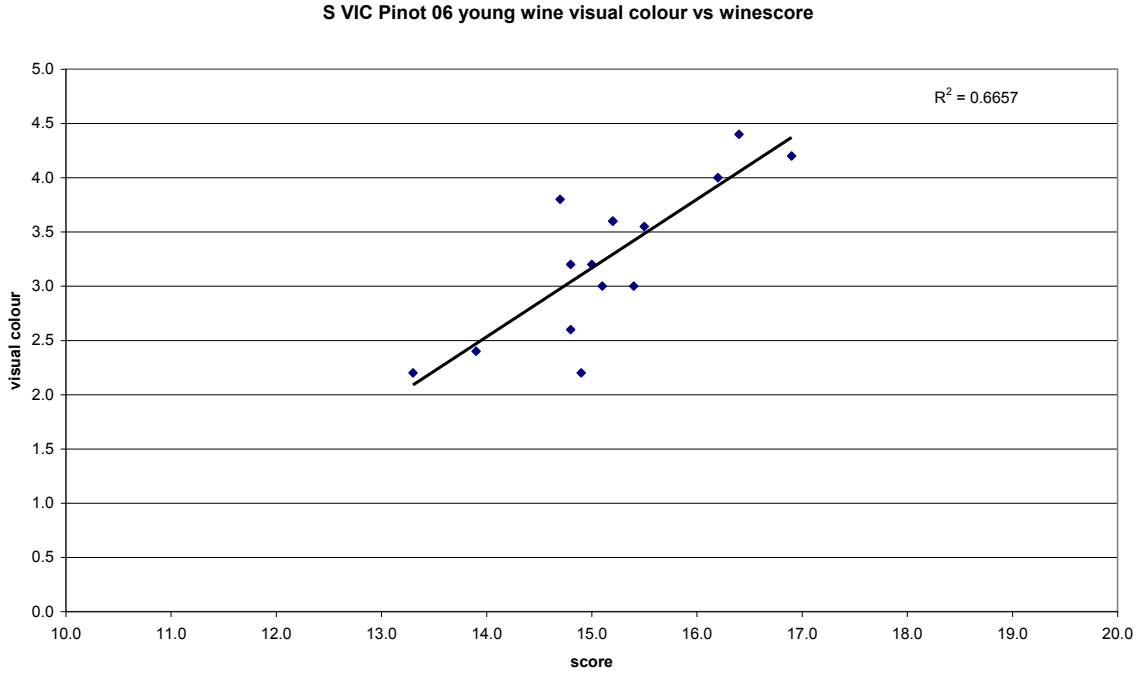


Fig 72a: This year 4 wines had better fruit scores than 3.5. Fruit scores were highly correlated to wine scores

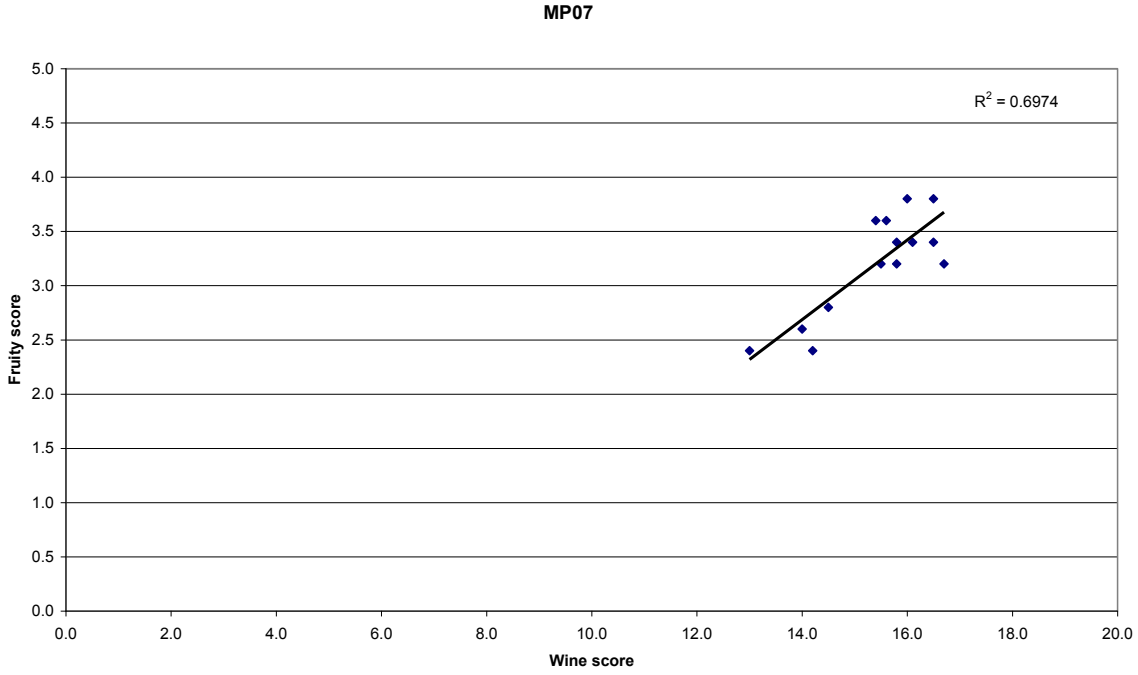


Fig 72b: Last year the fruity-score correlation was also significant – more wines reached fruit scores above 3.5 but some were rated lower for other reasons.

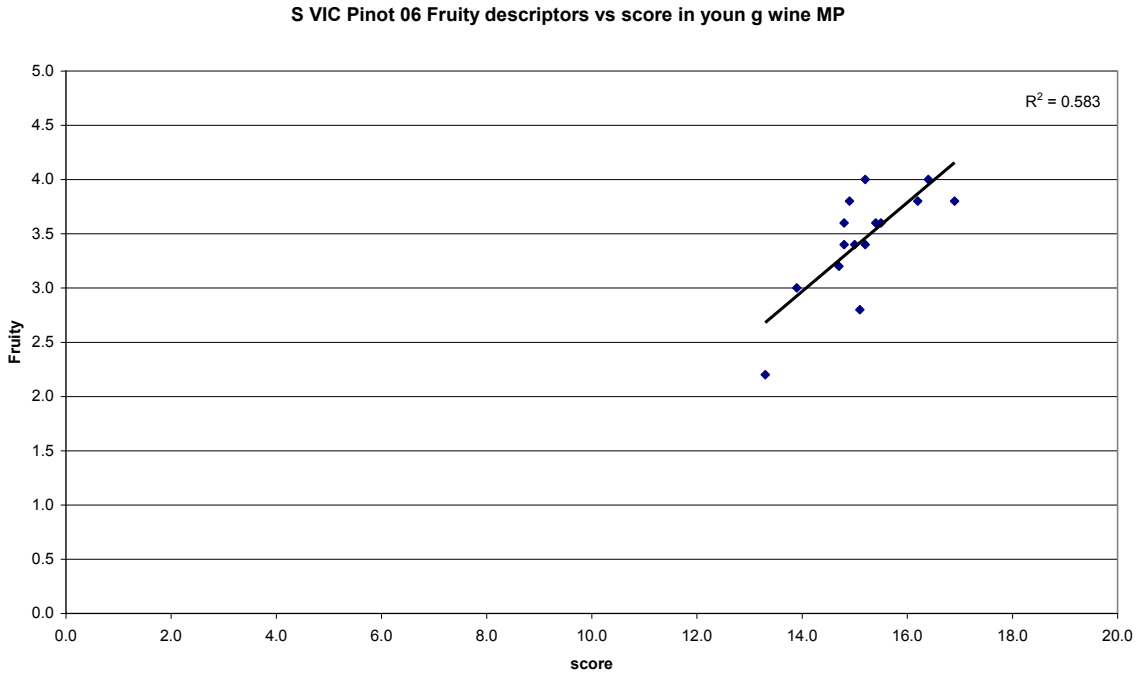


Fig 73: Comparison of this years and last years fruity scores

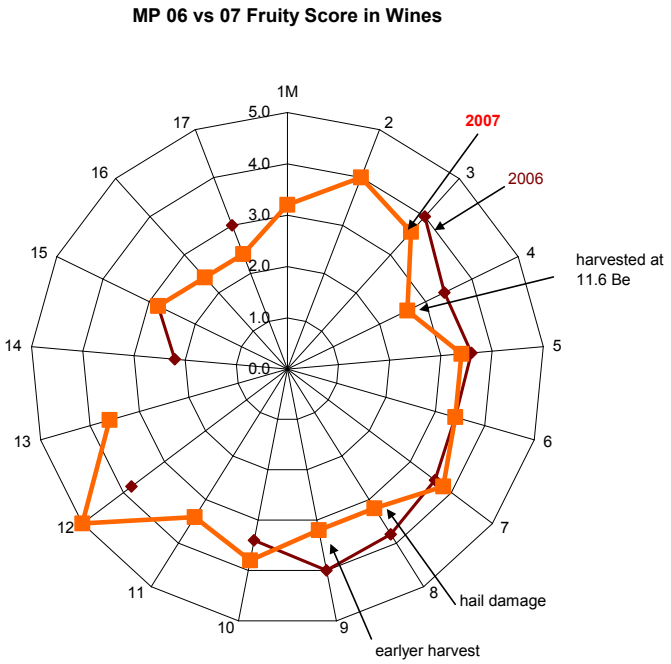


Fig 74: Fruitiness is not related to amounts of degree hours (bunchzone temperature x hangtime)

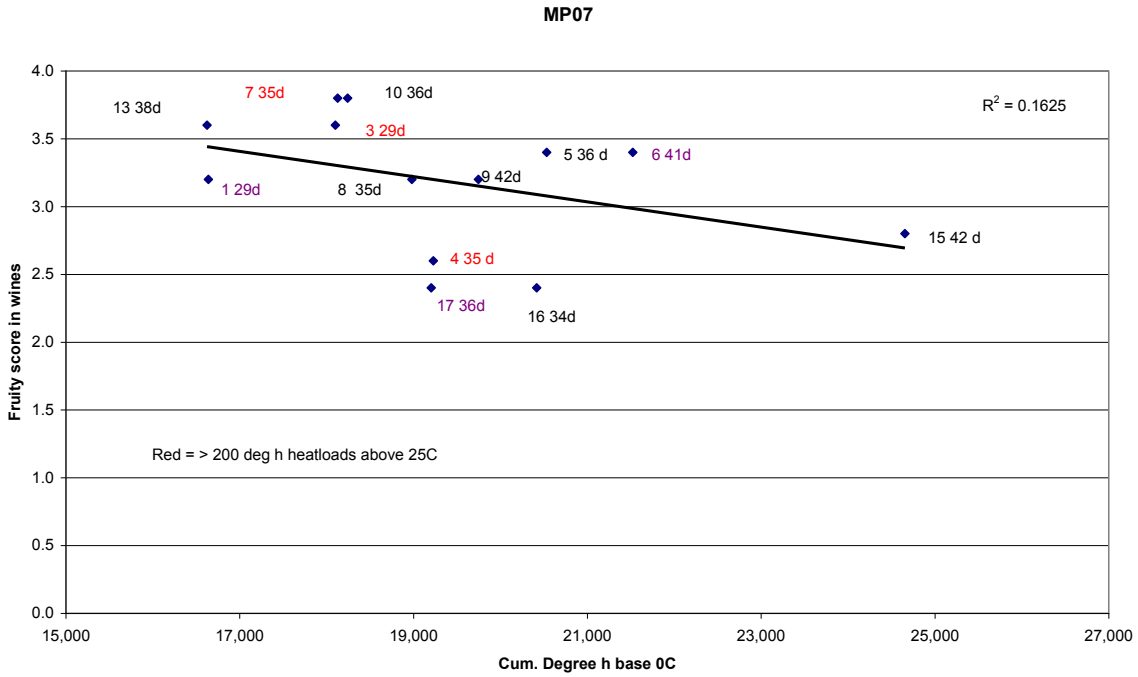


Fig 75: Fruitiness was good at a vine balance of around 20, (and was uncorrelated to total active leaf area).

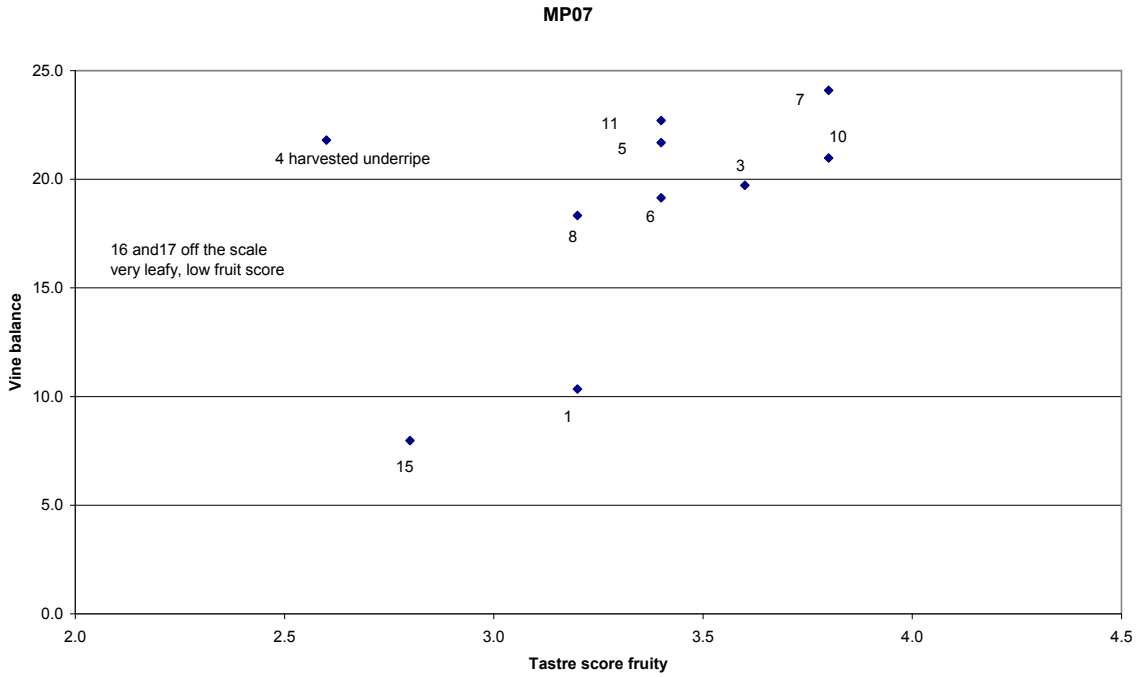


Fig 76: Fruitiness is not related to fruit loads per shoot.

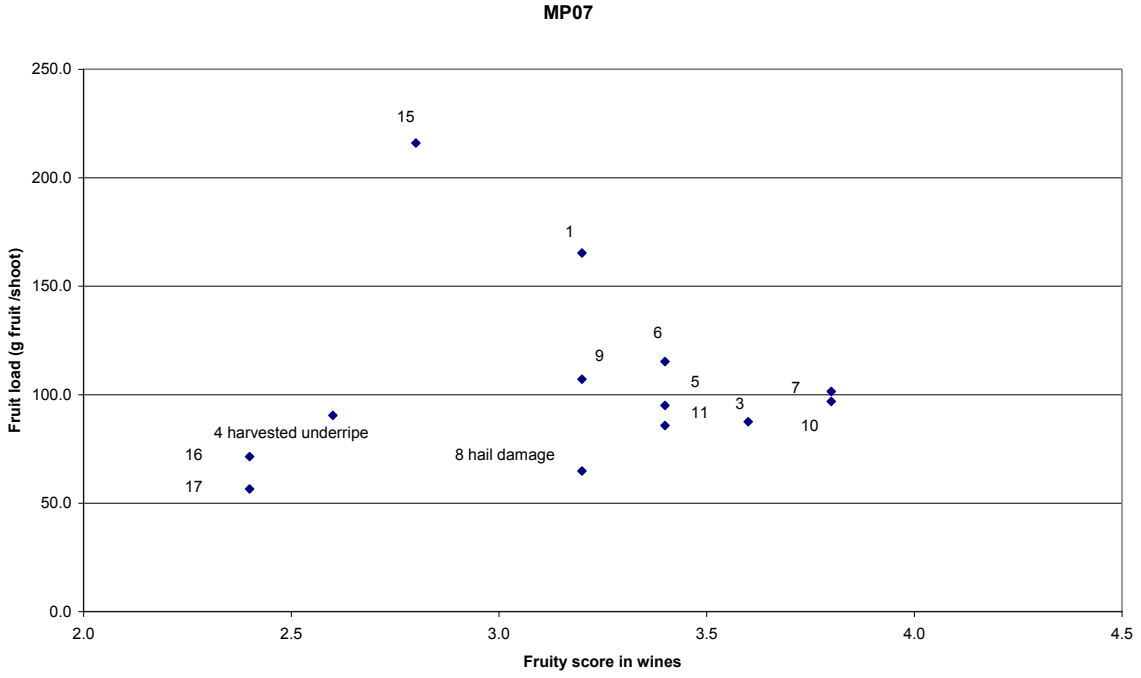


Fig 77: Best fruity scores with leaf area to fruit ratio between 15 and 25

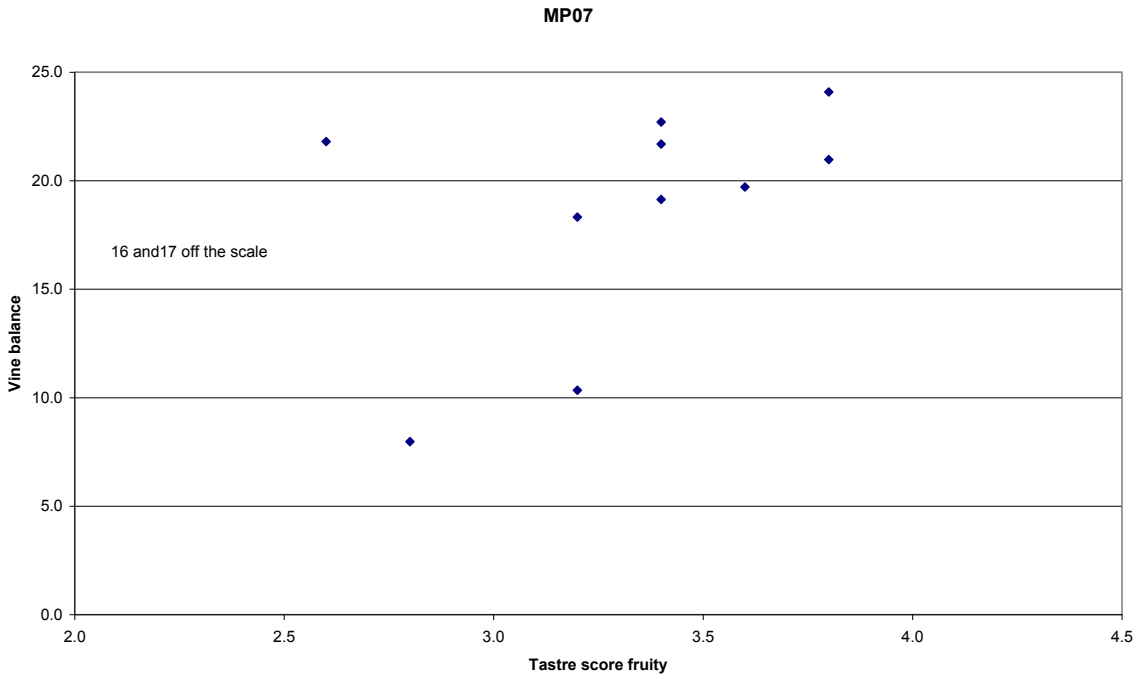
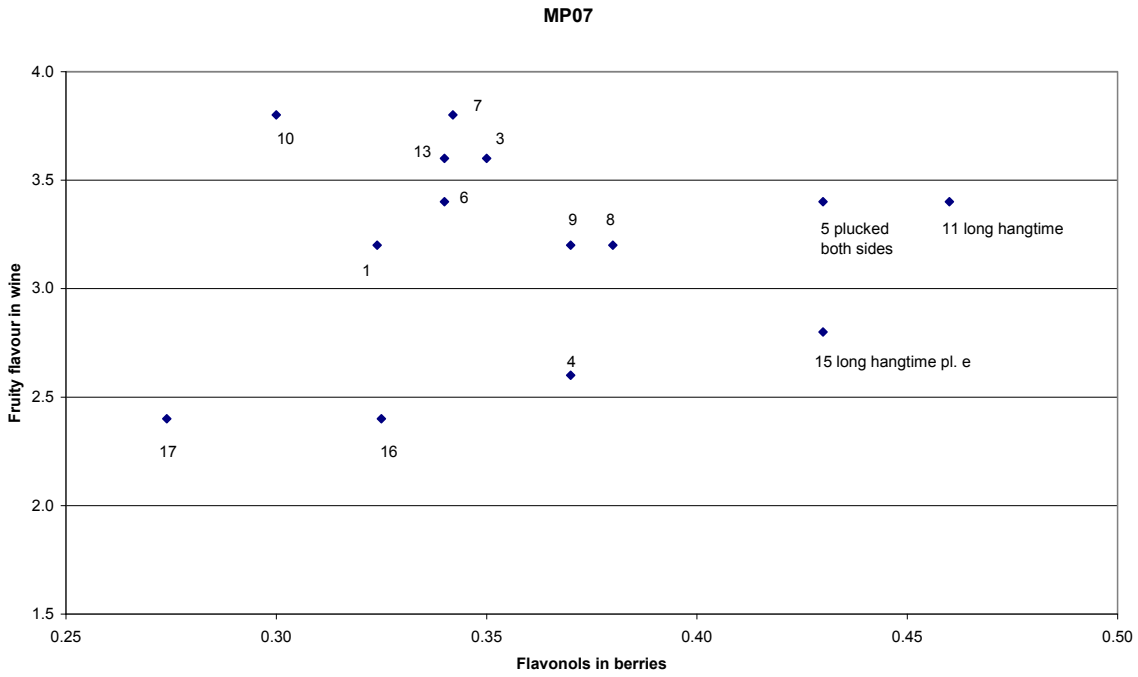


Fig 78: Best fruity scores were obtained with moderate flavonols.



Fruitiness is not related to TA in berries.

Fig 79: Floral aromas did not correlate with wine scores and were low in wine from the site with the highest average heatloads (4), the wine with the extreme greenness (16) and from bunches with long hangtimes. Scott Henry seems to produce floral aromas later.

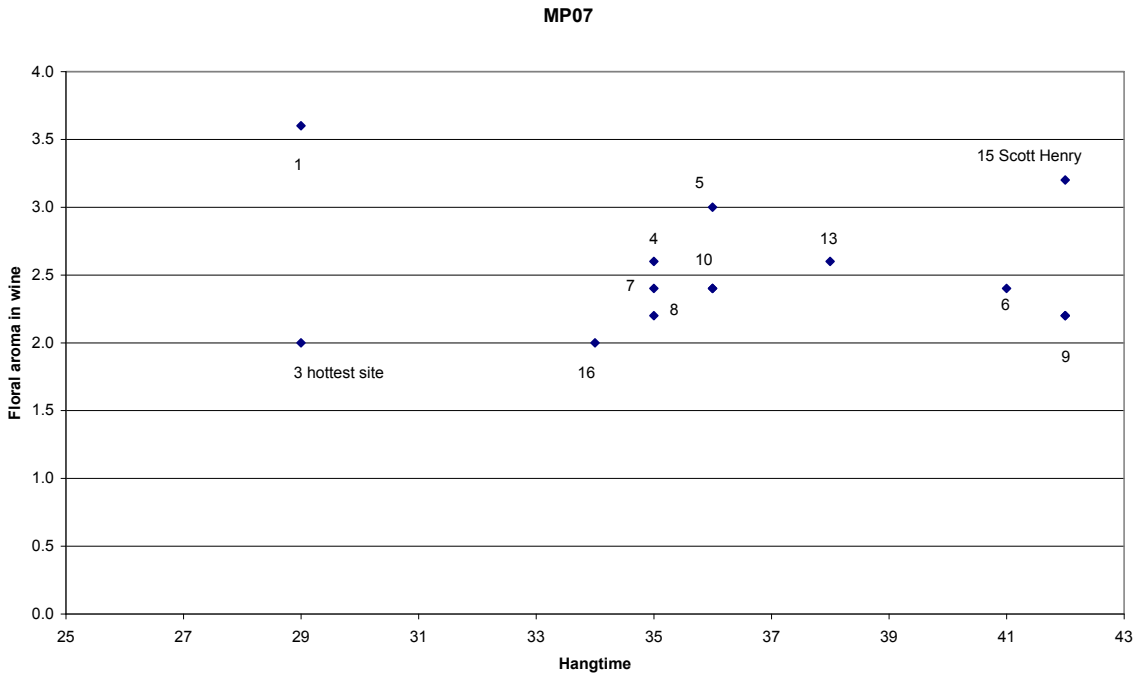


Fig 80: Floral aromas were lower in many wines in 07 due to higher heat

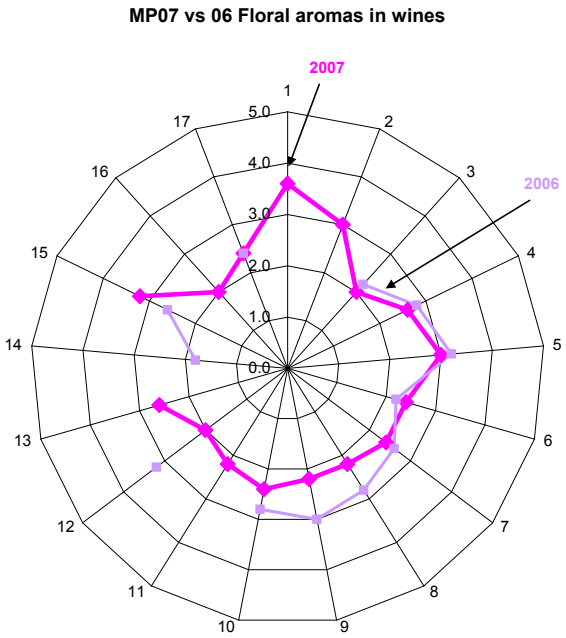


Fig 81: Many wines were less "green" than last year.

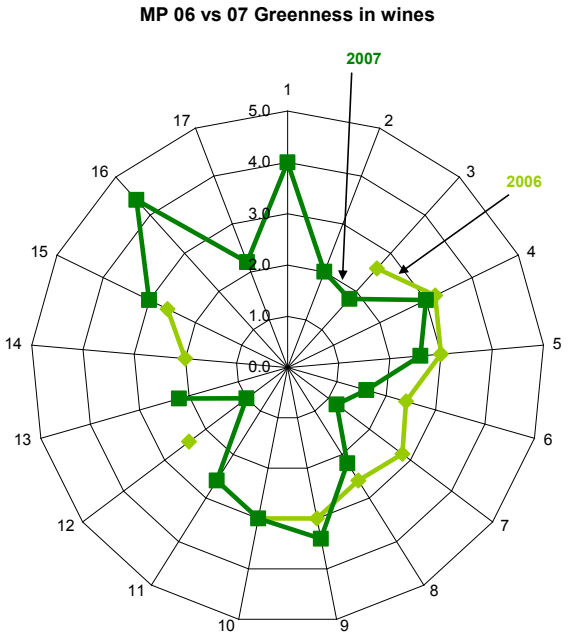


Fig 82: Greenness was not significantly correlated with wine score (17 excluded) due to small number of data points which are comparable

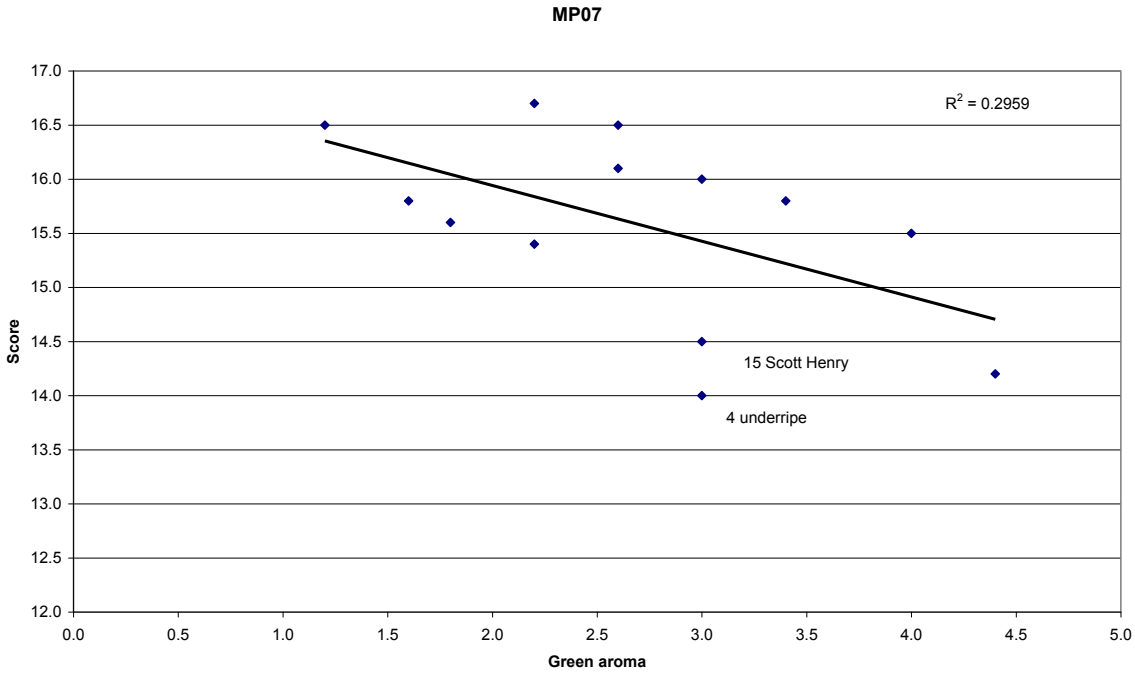


Fig 83: Greenness in wine correlated with lack of cane lignification

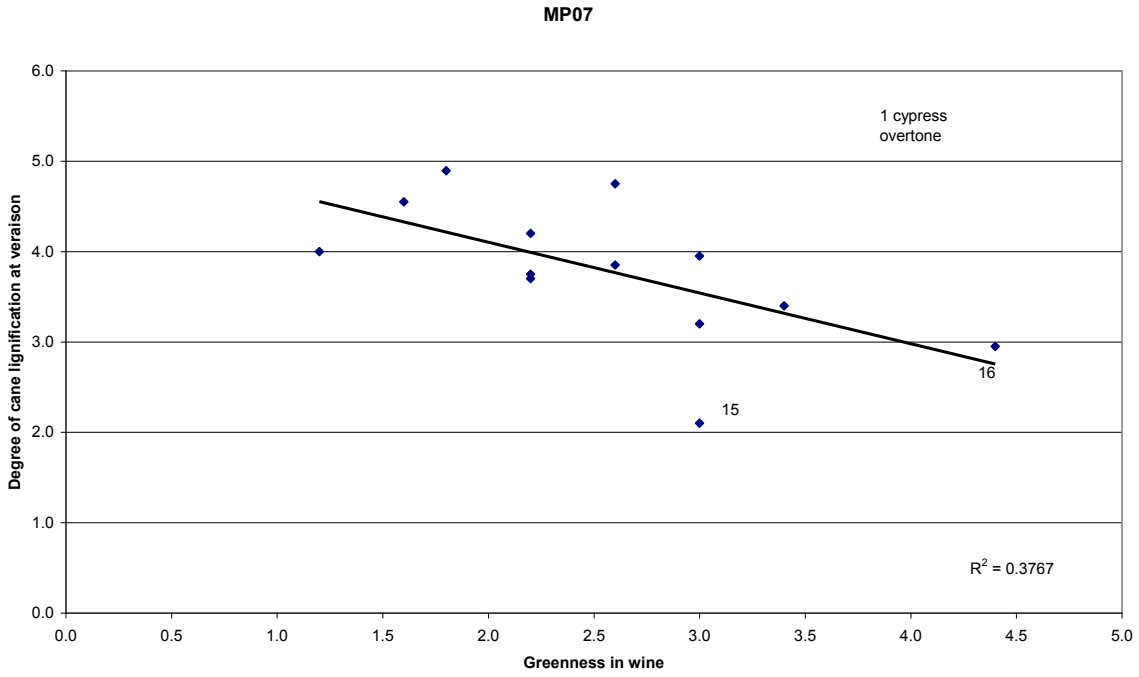


Fig 84: Greenness in wine was correlated with seed unripeness.

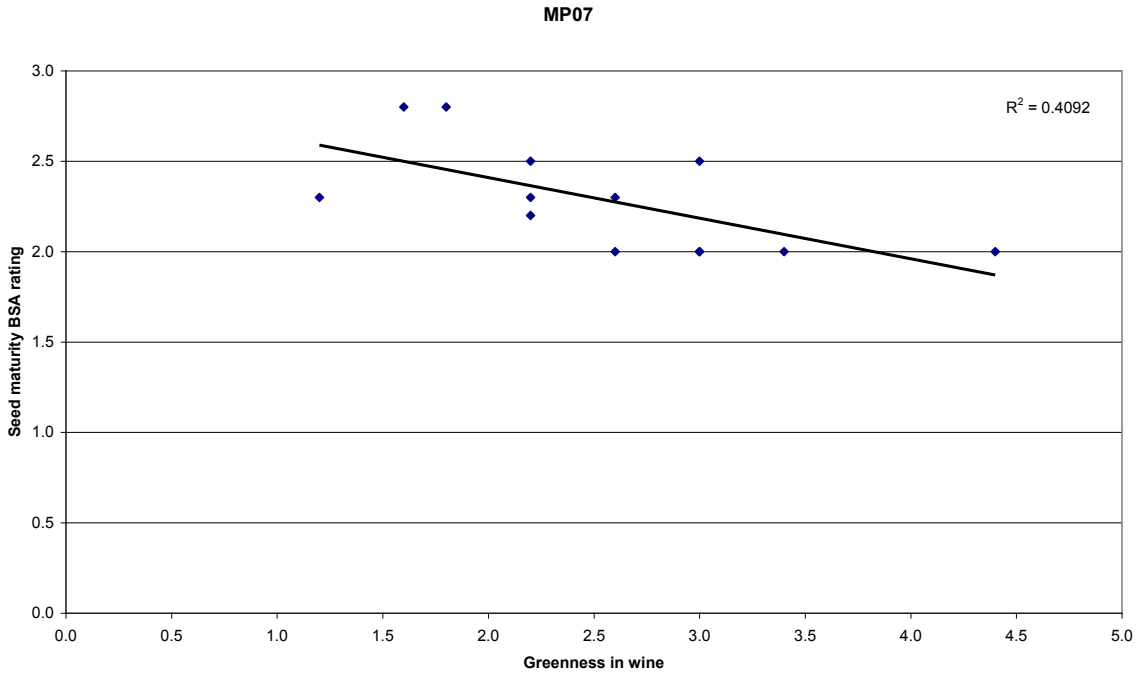


Fig 85: The riper the grapes the lower the vegetal aroma

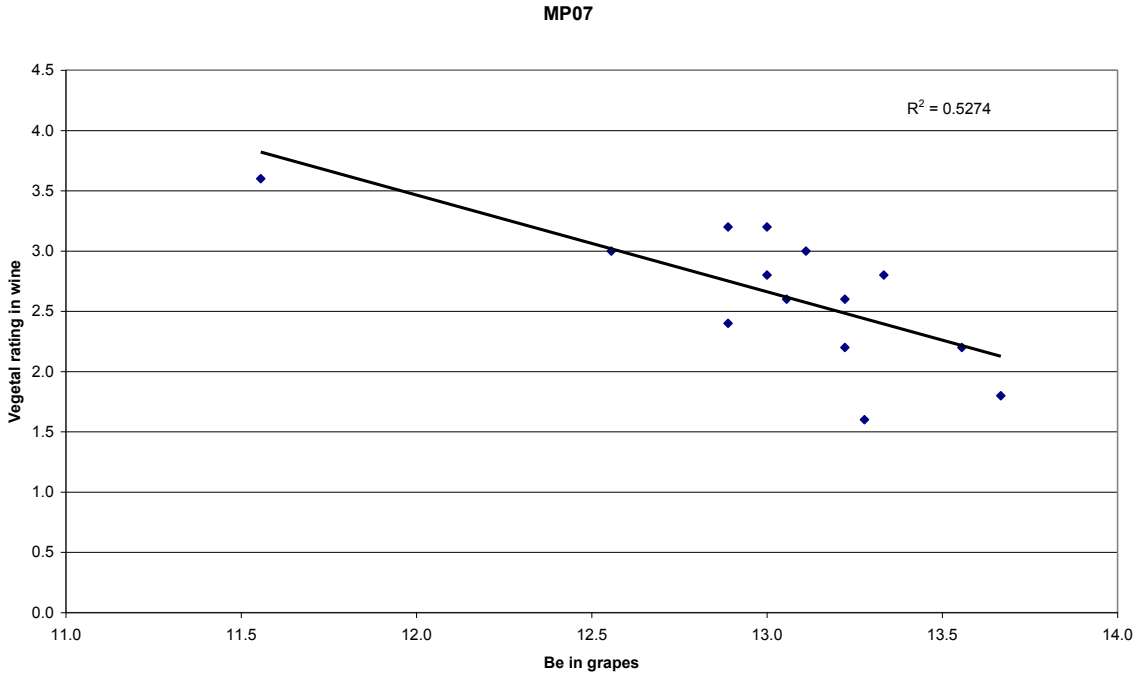


Fig 86: Vegetal aroma in wine was correlated to malic acid (but not TA) in grapes.

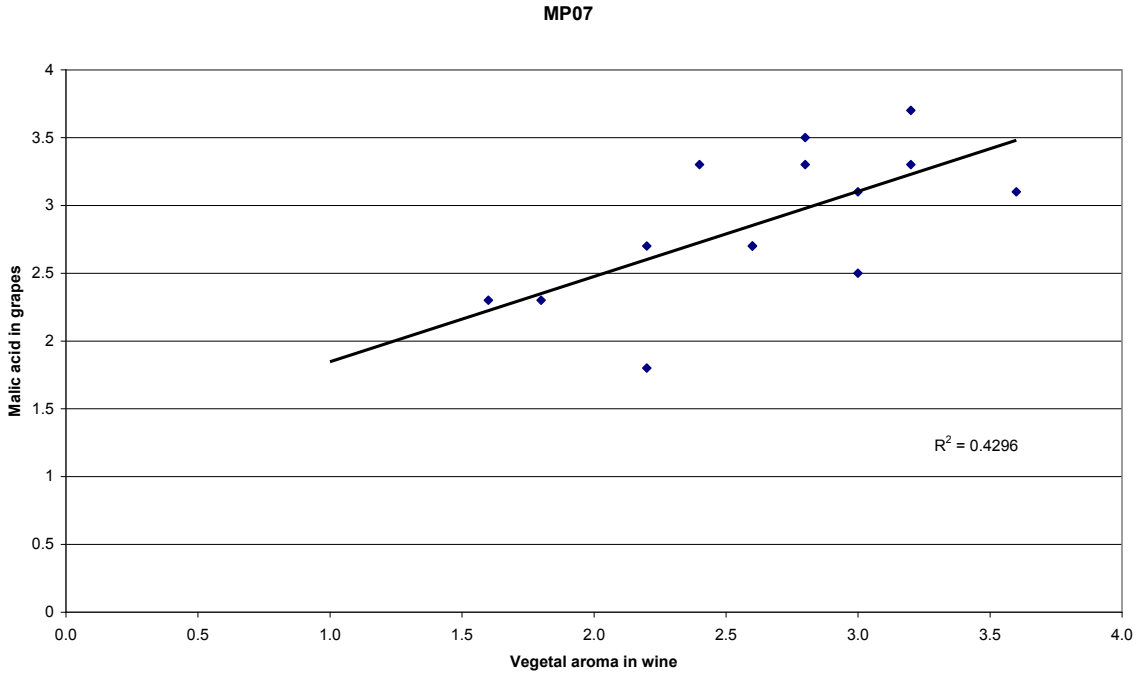


Fig 87: Bitterness in wine above 2.5 coincided with low seed maturity but there were some wines from grapes of immature seeds that had low bitterness (winemaking skill).

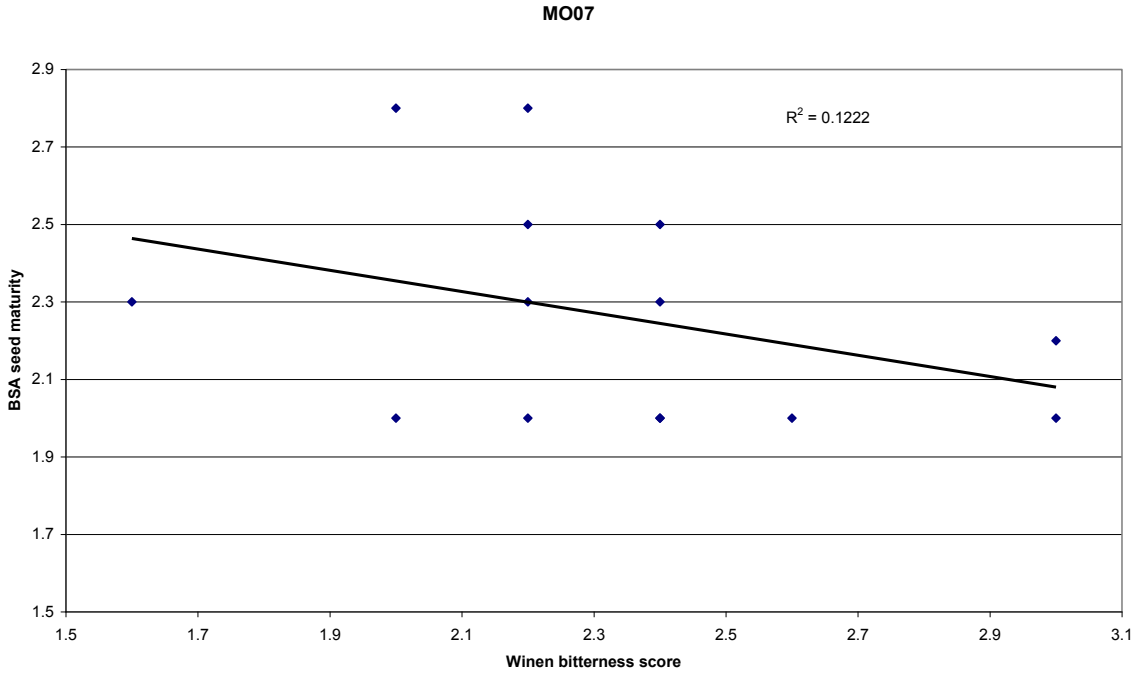


Fig 88: Body in wine was correlated to Be in grapes.

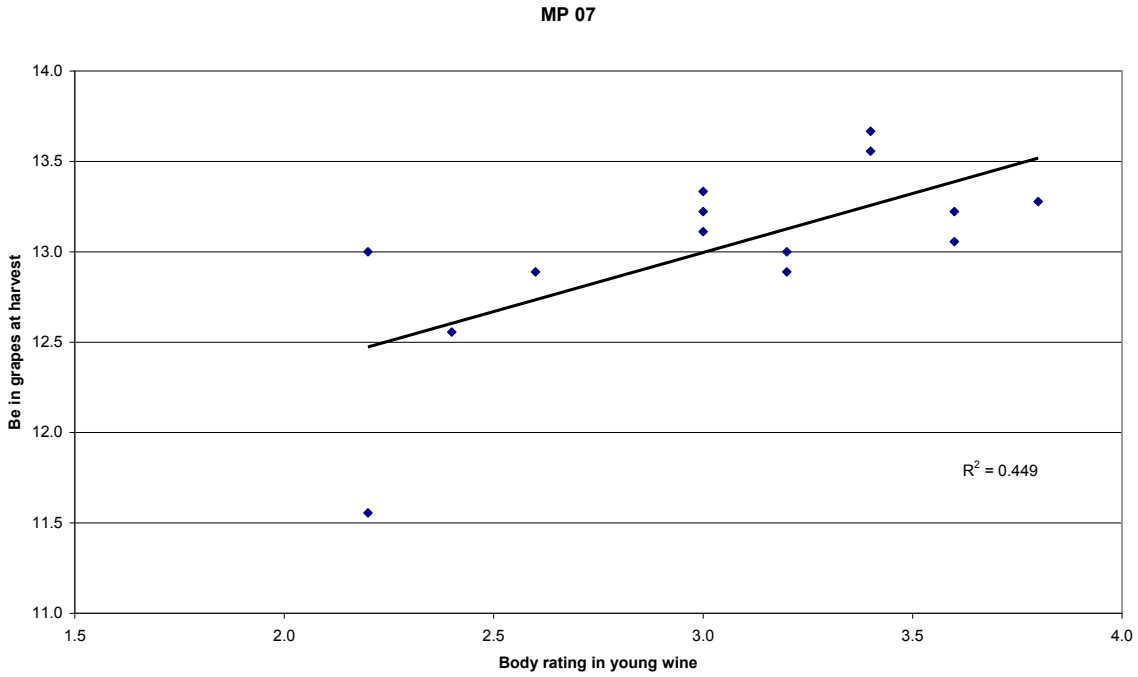


Fig 89a: Tannin softness (texture score) was higher when skins were more mature, there were more mature skins this year, this was unrelated to irrigation or dry land farming

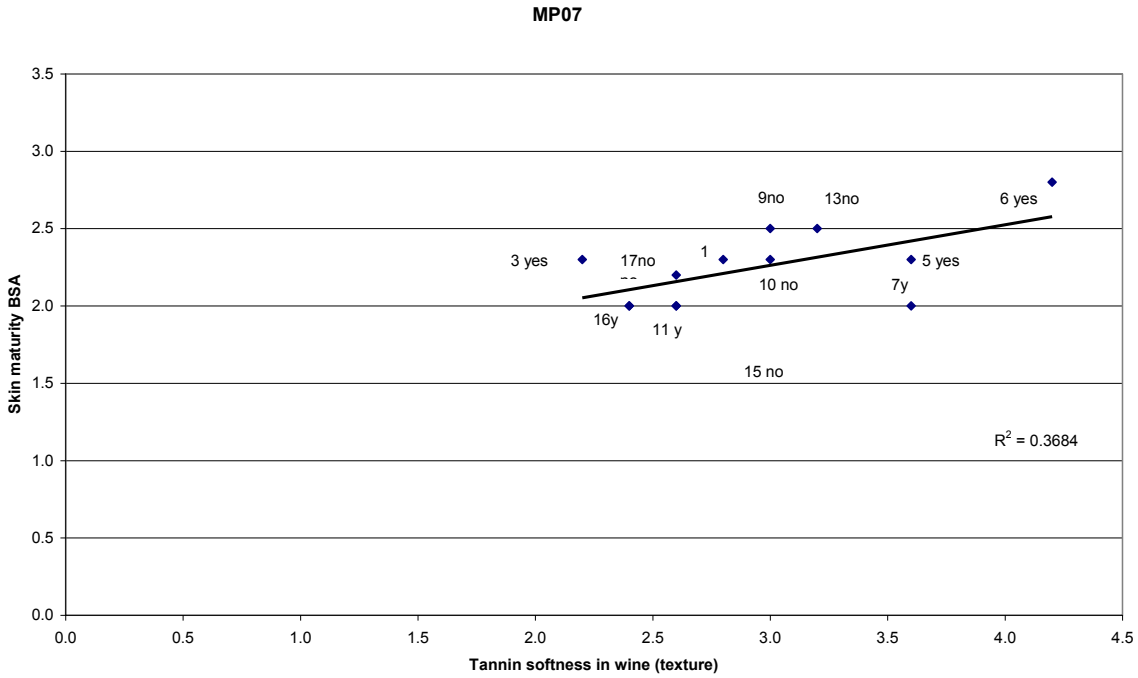


Fig 89b: Tannin softness was unrelated to BSA skin maturity as most berries were raisined or shrivelled with retarded skin maturity.

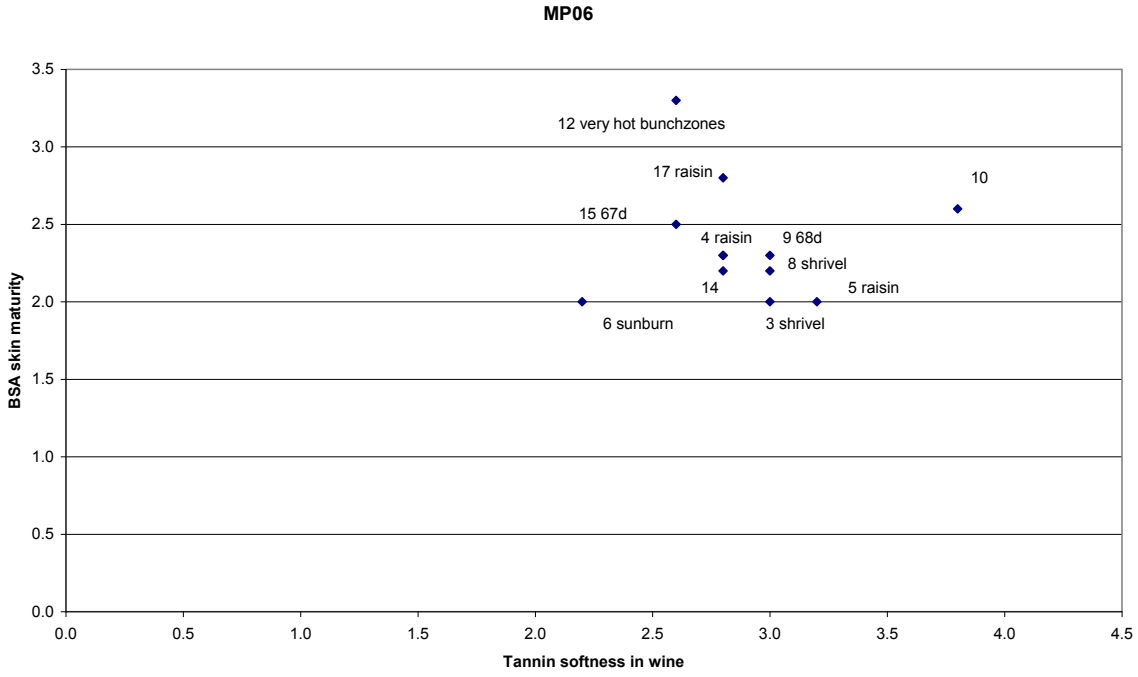


Fig 90: Tannin softness in wine was not related to BSA seed maturity (winemaking skill with immature seeds!)

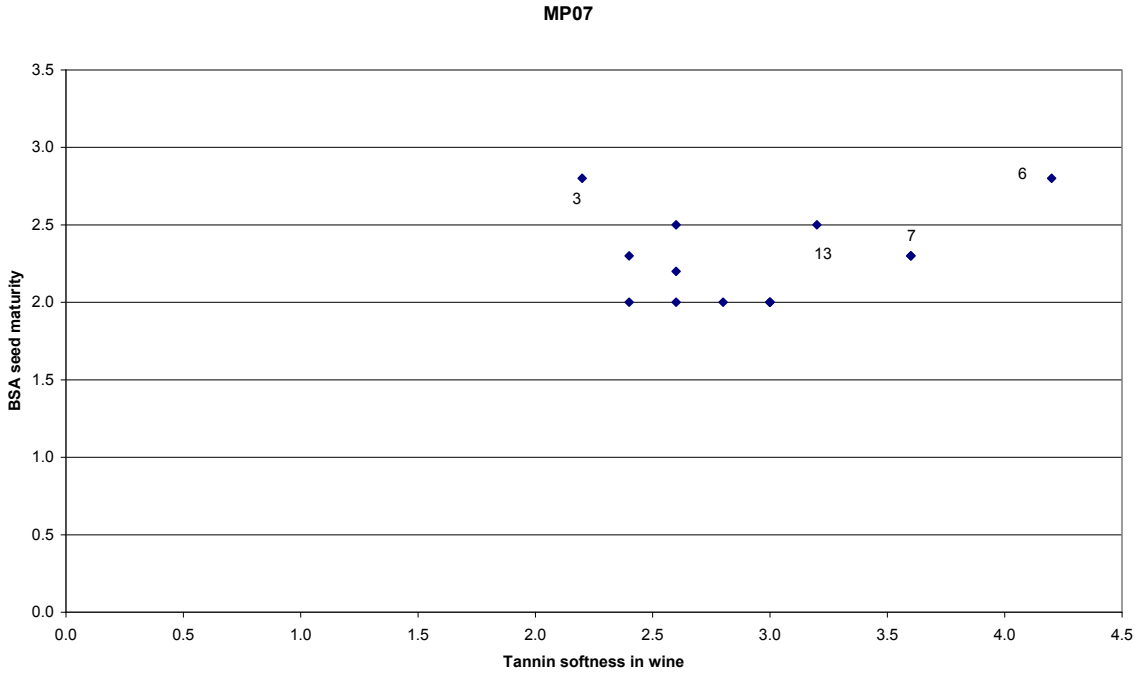
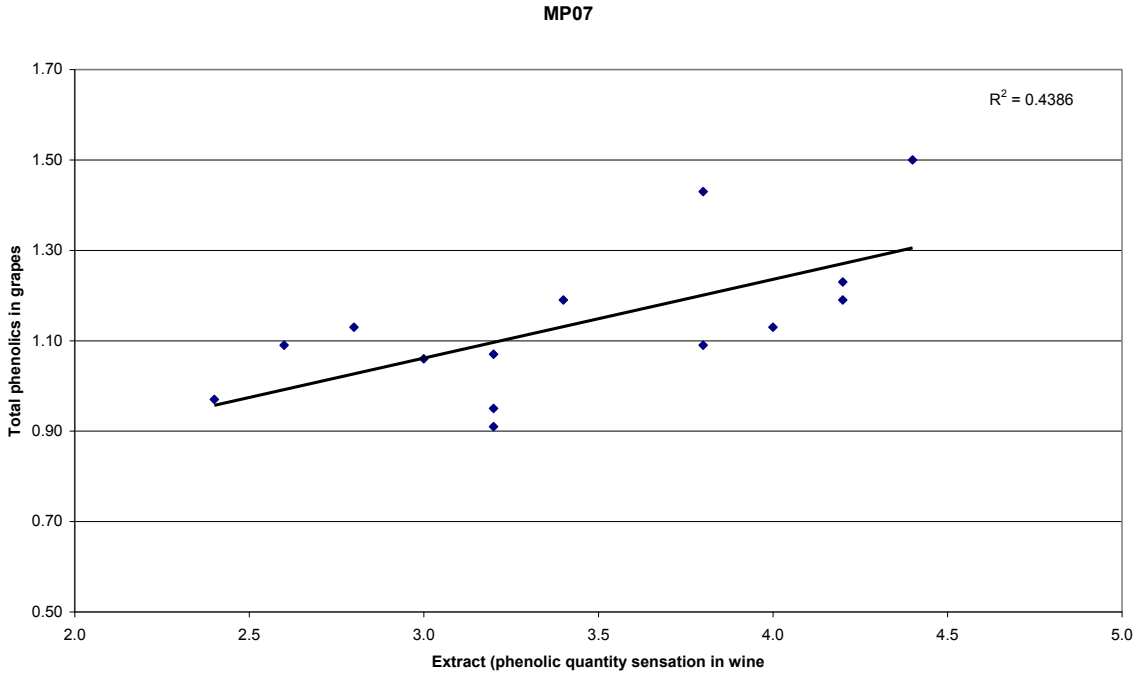


Fig 91: High phenolic sensation in wines (extract rating) was related to high total phenolics in grapes.



Young wine chemistry

Fig. 92: Sugar in berries were related to alcohol in wine except in vineyard 11 and 6 and 4 the latter was harvested underripe

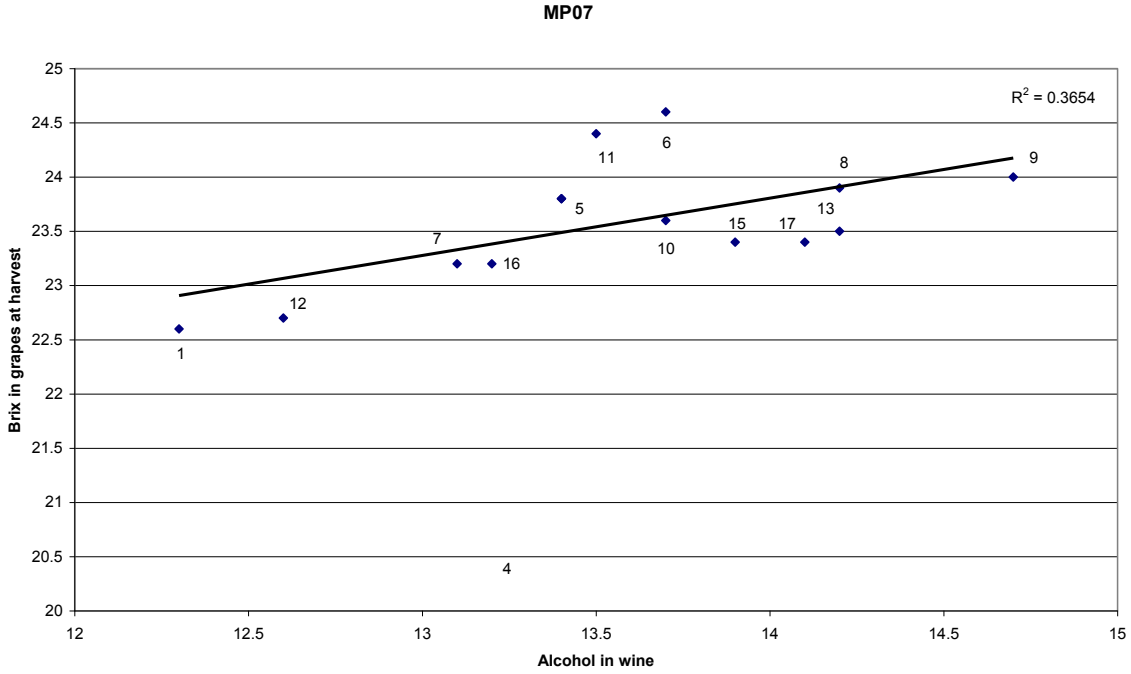


Fig. 93: Colour in grapes was slightly related to colour in wine.

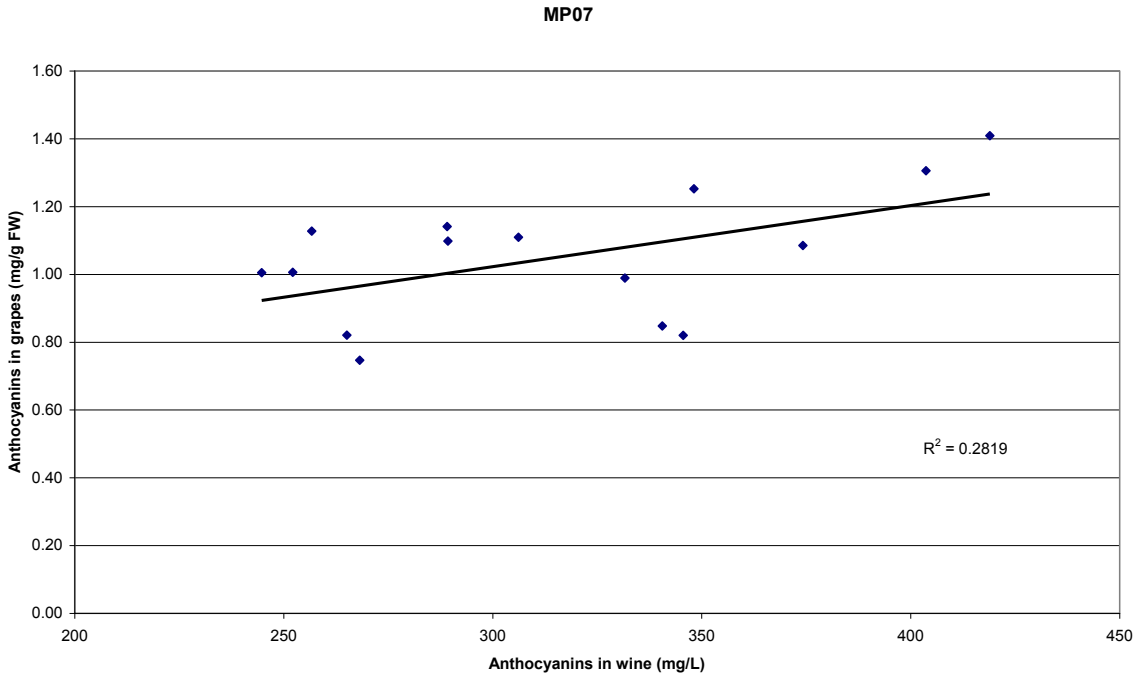


Fig. 94: Colour density as analysed in the lab correlated with colour density judged visually.

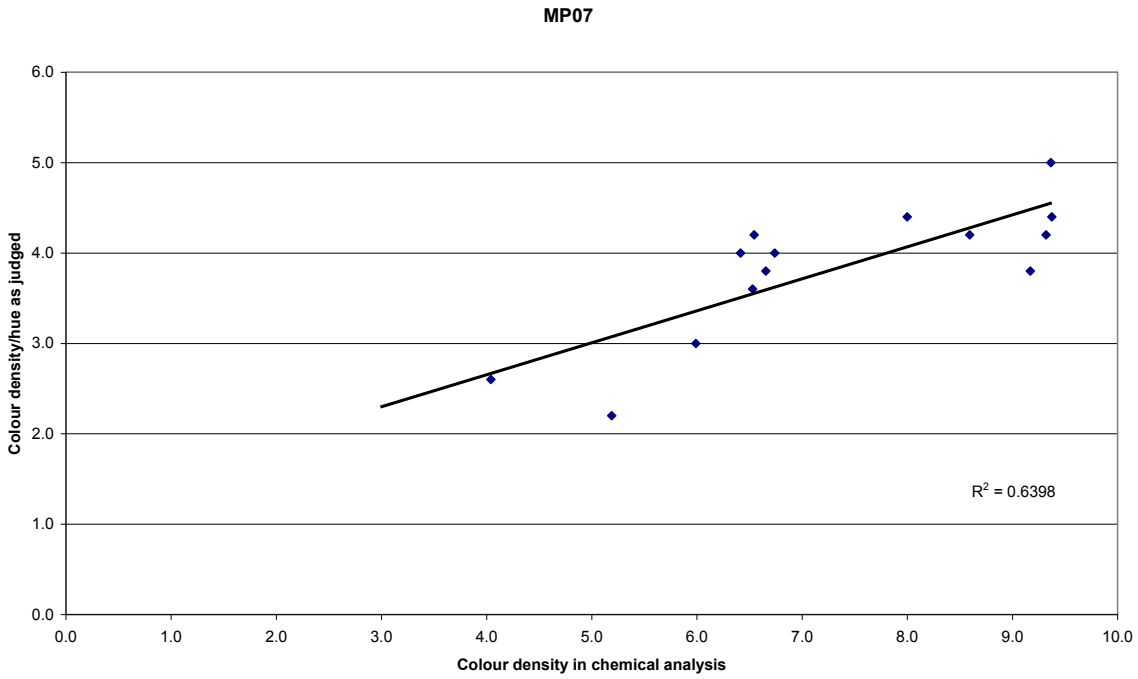
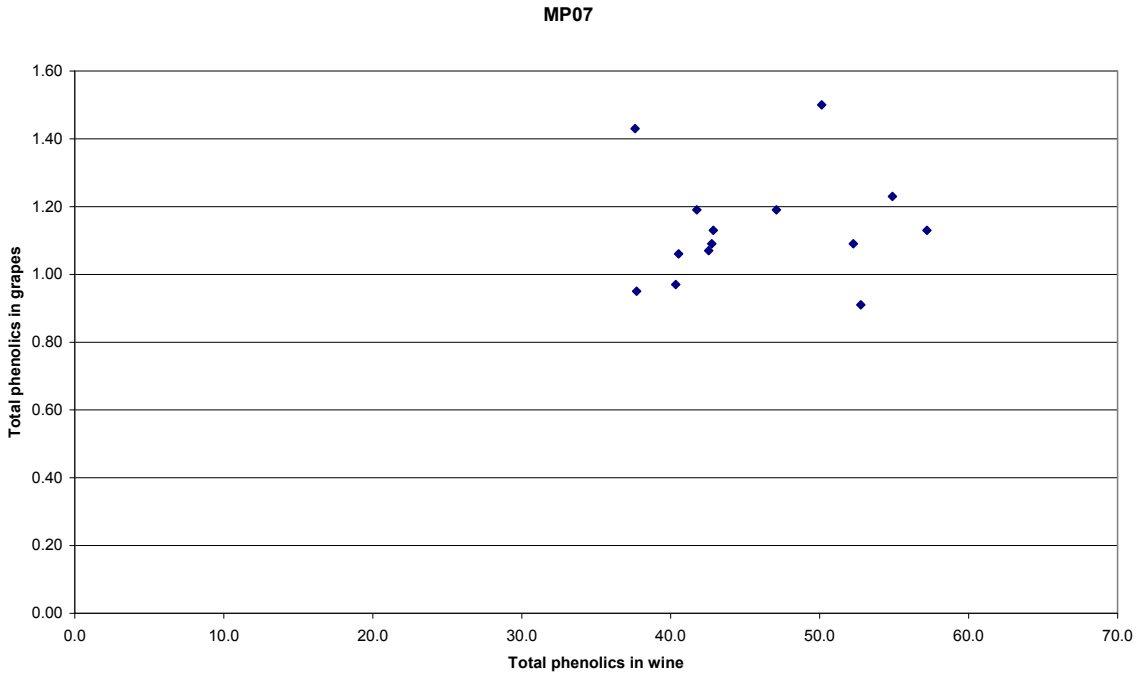


Fig. 95: Phenolics in grapes were not related to phenolics in wine. This shows the impact of winemaking



Flavonols in grapes were not related to flavonols in wine. Tasting scores were even less related to wine phenolics than last year but in general phenolics were higher

Fig. 96: Tannins in wine measured by the AWRI correlated highly with total phenolics in wine measured by Vintessential.

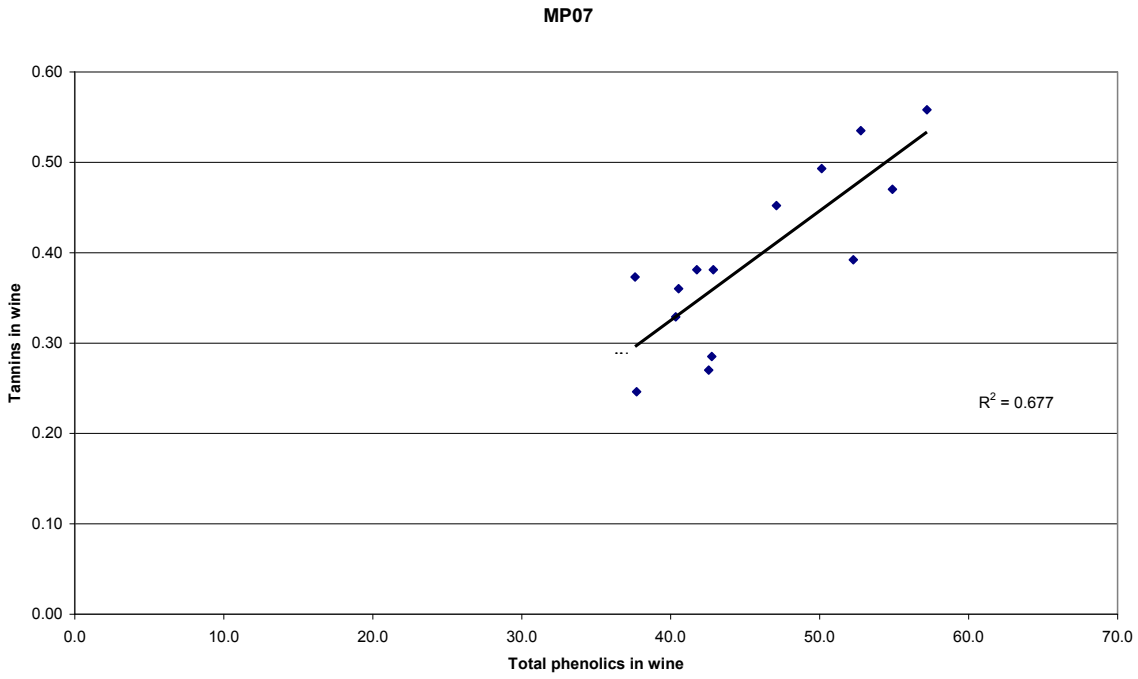
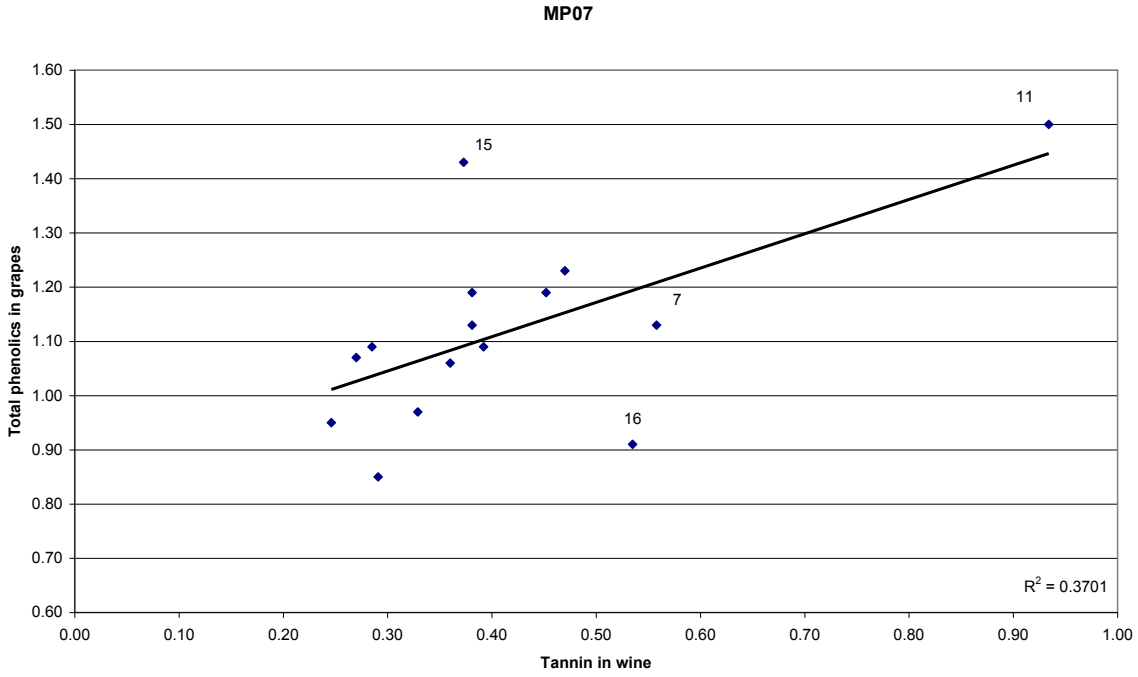


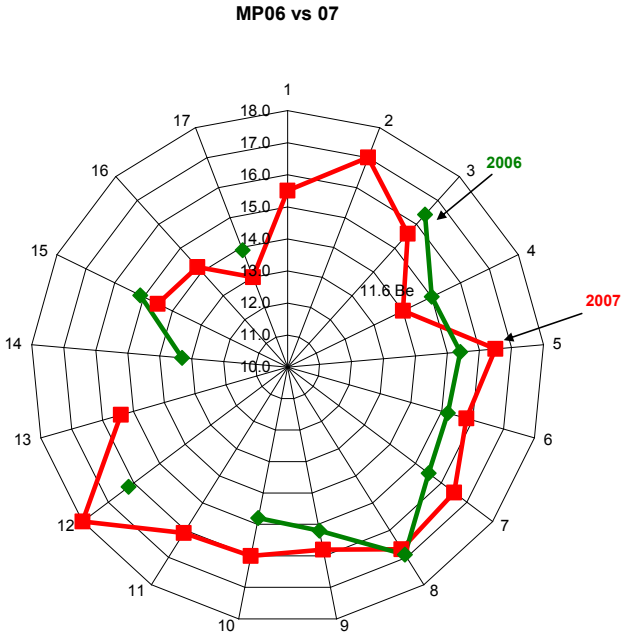
Fig. 97: Tannins in wine did not correlate well with phenolics in grapes, as there were many outliers, as winemaking can manipulate tannin extraction.



Synopsis

	Mornington Peninsula 06	Mornington Peninsula 07
Climate	**Warmer than** average during day except Feb normal **Night temperatures below average** except January	From December **above av. daytime temp with extreme heat in Feb and hot March.** Very cold nights Oct Nov and **very warm nights in Jan/Feb.**
Rain	**Above av in Dec and April, below av in March**	**Below average all season**
Vineyards	**Vine balance on average 13 (8-23) with only 3 out of 17 very leafy** **80% trimmed shoots with 1 growing tip and 44 leaves** **Bunches on average 90g** **Hangtimes on average 51d**	**Vine balance on average high** (20 ranging 8-32) -**determined by low fruit weight.** Eight out of 14 **very leafy** with **lower amounts of trimmed shoots (50%) than last year** containing on average 2 growing tips and 55 leaves (more than last year). **Bunches low in weight due to bad set and drought** (on average 64g), **Hangtimes short** (on average 36d)
Bunchzone temperatures	Cum deg h on average 21,000 (range 15,000-26,000) Very large range of healtloads. Except No 1 ver. – har. av. deg h all below 500, cold nights Eight vineyards with more than 15 av. degree h below 15C. Grapes are only on average 437 h in the beneficial bracket	**Cum deg h on average less than last year due to short hangtime**, (17,000-25,000). **Warmer year** (average deg h in all but one higher than 500). **Heatloads unrelated to last year's** due to different hangtime and management. **Only a third of the cold hours than last year! Grapes spend more hours (av. 509) in the beneficial bracket**.
Baumé	Between 11.8 and 15.2. Be independent of berry weight. **Sugar loading unrelated to vine balance** but somewhat to growing tips	Lower than last year (between 11.6 and 13.7) not related to wt, yield, balance. **Sugar loading slower with more growing tips.**
TA	TA independent of day temperatures. More rapid TA degradation with less daily night-time temp below 15C	**TA degradation faster than last year** with less daily and total night-time temp below 15C.
Colour	**Higher** colour values at harvest with **more sun exposure in particular to west and north,** shrivel, **later harvest**.	**Warm but not hot bunchzones may best for colour formation. This can be achieved by plucking east. Hot bunchzones lead to shrivel. Drought stressed and very leafy vineyards do not reach potential.**
Phenolics	**Higher values per day in warmer bunches** and **short hangtimes**	**Higher values with 0.8 leaf layers and warmer bunches** (plucking west) **or longer hangtimes** in cooler conditions.
Berry condition & BSA	9 of 22 shrivelled or raisined - BSA not related to bunchzone temperatures or sugar.	Very little shrivel. **Better ripeness in warmer bunchzones and with higher sugar.** Bad cane lignification goes with low BSA.

Fig. 98: Wine scores in 2007 vs 2006. Six out of 09 wines which were in the group both years had better scores than last year.



Wine traits relevant to wine score	Mornington Peninsula 06	Mornington Peninsula 07
Wine visual colour	Important to wine score and not related to grape colour due to shrivel	**Related to grape colour and important for wine score**
Wine fruitiness	Not dependent on fruit zone temperatures but **better with vine balance** 10-20 and longer hangtimes in favourable conditions	**Significant trait.** Not related to bunchzone climates. **Better with moderate vine balance** (15-25), longer hangtime in cooler sites and moderate exposure.
Wine greenness	No effect of bunch temperatures, and seed ripeness as too much shrivel.	No effect of bunch temperatures but **related to lack of cane lignification and seed ripeness.**
Wine vegetal aroma		**Related to malic acid**
Wine bitterness		**In some cases related to unripe seeds**
Wine tannin quantity (Extract)		**Related to berry phenolics**
Wine tannin softness (Texture)	Unrelated to BSA skin maturity due to large percentage of shrivelled or raisined berries	**Better when skins were maturer** (hardly any shrivel this year)
Wine body		**Related to berry Baume**
Total wine score	No correlation to h in beneficial temp. bracket and leaf area or vine balance.	**High from ripe colourful fruity unshrivelled grapes with good acid, from moderately exposed bunchzones on balanced (15-25) vines with lignified canes. Higher with high ratio of young to active leaves and more growing shoot tips.**

Discussion

This second year of benchmarking Pinot noir quality in the Mornington Peninsula has been undertaken to give each participating vineyard/winery detailed information on their vines, grapes and wine and enable comparison with others within the region.

Only blocks with ungrafted **clone MV6** were chosen to reduce variable s between vineyards. Many wineries mix wines from different clones (which convey different wine attributes, see *Henschke, 2007*) and end up with quite a different commercial wine than the young wines that were tested in this study.
Except for two vineyards with Scott Henry trellis all vines were trained to **VSP**. Scott Henry has a different growing dynamic and is in many cases difficult to compare (see correlative graphs).

Vineyards were between 8 and 22 years old and vines are expected to be managed to be in **root-shoot balance**. For Pinot noir this was shown (*Petrie et al., 2000a*) to be genetically set at a 1:1 relationship, regardless of crop load or defoliation treatment. Defoliation led to compensation by the remaining leaves in size and weight (with delay of fruit ripening if severe) and partial crop removal led to higher above and below ground non fruiting biomass (up to a sink limitation point). This will only happen with sufficient water and nutrient supply. Shoot growth in many sites in the MP can be vigorous and will need management, especially in years of high seasonal rainfall. Management is possible through balanced pruning (bud numbers), trellis type, shoot removal and trimming, with trimming being undertaken in every vineyard in this study.

These manipulations and partial fruit removal will change **vine balance** *(Howell, 2001).* Many of the „rules of thumb" that appear in the literature use simplified **estimates of leaf area**. For example the "6 leaves per bunch" rule which is very unreliable as sizes of leaves or bunches vary between varieties, climates and seasons. Most research reports use „total leaf area" per g of fruit which, in crowded canopies in particular, over-estimates active leaf area. Using total leaf area, vine balance correlations will be different for trellis systems as they result in various amounts of shaded leaves. Leaves that are shaded most of the time do not contribute carbohydrates and may even draw them away from the fruit. In some trellis systems, outer leaves may not be fully productive due to too much light for full leaf function (reversible photo-inhibition). Leaves in the two layers below the outer leaf layer often are very productive with enough light due to the movement of the outer leaves in the wind. In Australia, at temperatures of 15-33^{o}C, 30% of full sunlight is sufficient for near maximum leaf activity. Photosynthesis still can be high at ambient temperatures above 35^{o}C provided there is water to ensure leaf cooling and stomatal opening. Sugar production is, – as has been seen in the last 2 years, not a limiting factor for MP Pinot noir, in particular when seasons are warmer than usual. What we have measured as heatloads in this benchmarking study is heatloads for bunches, not for the leaves. Of course, in the case of high exposure, water stress, nutrient deficiencies and diseases leaves may overheat and not be very productive. Heat sensitive cameras are modern tools to assess leaf water stress *(Guisard and Tesic, 2007*) but have not been used in this study.

Assessing active leaf area is important (*Winter and Whiting, 2001*), as in this way it is possible to generate comparable values for many trellis systems. The recommendations that some authors have arrived at are open to interpretation. Often the situation under which the research work was conducted does not necessarily represent what may be the situation in a MP vineyard. An average guideline of 12 cm2 of leaf area per g of fruit was proposed by *Smart (1990*). A variation of between 6 and 15 has been proposed by *Smart and Robinson, (1991),* with the indication that lower values are required in warmer climates and higher in cooler areas. Limited vine balance data are available for hot Australian areas, particularly under reduced water availability. Plants under such conditions draw upon root reserves (reviewed in *Chaves et al. 2003*). Different vine balance values have been reported for different trellises, as total leaf area (exposed and

unexposed) was usually measured. For example, *Kliewer and Dokoozlian (2001*) reviewed Californian work, where the optimum total leaf area per crop weight for rapid sugar accumulation in Chenin blanc on a lyre type trellis was about 6 cm2/g fruit, whereas on a vertical shoot positioned trellis the optimum was about 9 cm2/g fruit. For Cabernet Sauvignon, the optimum values were 11 for Lyre and 14 for VSP. For cool climate Pinot noir, researchers in 3 continents found an optimum value of about 25 cm2/g for best fruit and wine quality outcome (*Vasconcelos and Castagnoli, 2000, Iland and Fetzmann, 2000, Whiting, 2001*). These data were however generated in Oregon, Burgundy and Whitlands (VIC) in cool years. Vine balance values obtained for the MP vines are a preliminary guide, but ideal values can only be determined for each site and management possibility (soil, water availability etc) over the succession of several seasons with their varying climates. Wine scores in the present study for 2007 were highest at moderate vine balance values (approx. 15-25), whereas last year these relationships did not emerge due to too many shrivelled grapes. Fruity aromas in wine may be greatly influenced by winemaking practice as most of them are only released during winemaking, however vine balance seem to have mattered in both years for fruitiness in wine. It may have an effect on precursors for fruity aromas which rely on appropriate sugar and hormone supply from the leaves.

Hormone balance (between the growth hormones Cytokinin and Auxin and the ripening hormone abscisic acid) determines the onset of cane lignification, colour change at veraison and ripening speed. Cytokinin is enhanced by high water supply, ABA by low water supply. Veraison is a time when manipulations in the vineyard can still change the fruit outcome when adapted to site and seasonal climate. Notably lower levels of cane lignification at veraison correlated with lower levels of seed ripeness and high greenness in the wine (when unripe seeds are extracted).

Cross sectional trunk diameters would be a means to measure long term growth response to the site (*Cortell et al. 2005*) and spatial variability across a block must be assessed so as to differentially manage and assess the vineyard (*Proffitt et al., 2006*)

Trimming will reduce the leaf to fruit ratio. In an experiment with Cabernet Sauvignon, *Poni and Giacino (2000)* that when shoots were trimmed to 12 leaves and laterals were removed, a total leaf to fruit ratio of 10.3 resulted, which reduced Brix, anthocyanins and phenolics compared to untrimmed vines. Under severe repeated trimming to 6 leaves and a resulting vine balance ratio of 5.2, the concentration of soluble solids was significantly lower and colour and total phenolics were poor. In another study (*Poni et al. 2003*) fruit quality was only acceptable at vine balance values above 14.5 cm^2/g - when laterals were retained on shoots with ten primary leaves. Laterals will later provide the leaves that maintain fruit ripening if there is a long hangtime intended. In experiments in Tasmanian Pinot (*Chopping et al., 2007*) similarly, trimming to 8 nodes instead of 12 reduced colour, and sugar levels at harvest. Canopies with 22 nodes had similar colour and sugar as those with 12 nodes and showed earlier onset of veraison. In the Fingerlake region in the northern USA, repeated shoot topping gave lower wine phenolics and anthocyanins (*Keller et al., 1999*) in particular with excessive N supply. It is recommended for the MP Pinot noir that petiole tests are used to assess optimum N for sufficient but not excessive growth and prevention of stuck ferments. Vigour should be such that no excessive trimming is needed and potential sources of photosynthates late in the season are preserved. *Keller et al. (2000a)* found that the rate and amount of sugar accumulation by the fruit reflected the photosynthetic activity of the source leaves and was independent of berry growth. However whilst still growing and unfolding, shoot tips become a sink for carbohydrate produced by mature leaves and may impact on sugar accumulation in berries. In the present study vineyards with many growing shoot tips had a reduced daily rate of sugar accumulation which may be beneficial when sugar ripening is faster than aroma development and phenolic maturity. Interestingly wine scores were better with more growing shoot tips at veraison and a higher ratio of young to mature leaves.

This season, most vineyards had either poor fruit set or undertook fruit thinning to manage yield targets. The optimal yield targets for Pinot noir in the MP had been by most participants either experimentally determined or adopted from European-based growing philosophies (eg in Burgundy), in which dense plantings and well drained soils with summer rains and dry autumns (in the best years) produce root systems that sustain only small crops. In these situations partial crop removal is the rule and shoot trimming is generally required. In higher altitudes (eg Switzerland) *Vasconcelos and Castagnoli* (*2001*) found that fruit thinning was be needed along with maintenance of functional leaf area (eg. from preservation of laterals) to ensure ripening in low light cloudy climates. The effect of crop thinning on yield components, fruit and wine composition and flavour, vine vigour, and wood carbohydrate reserves of Pinot noir was studied (*Vasconcelos et al.,2007)* at two locations in the northern Willamette Valley of Oregon. At both sites, crop was either thinned at bloom or at veraison. Wine was made from the highest and lowest crop levels imposed by thinning (45 and 25 clusters/vine respectively). Yields ranged from 2.2 to 6.6 t/ha. During the second season at site 1, soluble solids increased from 23.2 to 24.0 Brix when yields decreased from 7.1 to 3.2 t/ha. There was no response to cluster thinning on fruit composition at site 2. Despite the wide range of crop loads, cluster thinning had no impact on vine vigour or wood carbohydrate reserves over the two-year period at both vineyards. There was an increase in total anthocyanins and colour intensity in wine from fruit thinned vines at bloom as compared to veraison thinning. Aroma profiles were more affected by timing than by the level of crop removal. Earlier thinning did not improve aroma, but thinning at veraison increased strawberry aroma, and decreased grassy and woody aromas as compared to thinning at bloom. Wine astringency was lowest when vines were heavily thinned at veraison and highest for the same crop level when thinned at bloom. Notably this report stated that within a mid-cropping range such as is typical in Oregon; changes in juice and wine composition caused by cluster thinning were too modest to justify the losses in yield. Thus the need for fruit thinning must be revisited (appropriate yield predictions will help to establish that ratio (*Dunn and Martin 2003*), and be determined for each site according to root potential and for each season according to the climate. It can be conceived that under irrigation with well managed leaf to fruit ratios higher fruit loads than those displayed by many MP vineyards may be possible without quality loss - provided that fruit has the right hangtime under the right conditions. Some evidence may be gathered from the independence of fruity aromas in wines on fruit load per shoot.

Leaf health is crucial for the provision of photosynthetic materials, minerals and plant hormones to the fruit and vine. It also provides dappled light for the bunchzone and thus cooling during late season heat waves. Leaf health of older leaves was not ideal in 5 out of 16 vineyards either from lack of water (some poor leaf health occurred in irrigated vineyards) or lack of nitrogen (N). Bloom or post bloom N applications will prevent premature leaf fall in Pinot noir (*Wells et al, 2007*) but excessive N supply in combination with frequent trimming can impair colour and phenolic development (*Keller et al.,1999*). Growing conditions should be adapted to guarantee leaf health in cases where fruit zone temperature management through foliage is intended.

Leaf cover in 2007 was reduced in many sites due to desiccation and leaf drop but also due to deliberate leaf plucking, mainly on the south or east side of rows. There was no correlation of leaf cover with colour but grapes from warmer bunchzones had better BSA values (not really correlated with leaf cover) – it is known that phenolic and tannin ripening is better under warm conditions.

Bunch zone temperature measurement is a more precise assessment method of bunch exposure than counting leaf cover. Bunchzone temperature readings exceed by far the information of regional weather data or Growing Degree Day or Mean January Temperatures as an assessment of fruit growing conditions. The latter values do not take into account the duration of temperature extremes and are therefore not useful in predicting fruit quality or suitability of sites for Pinot noir. Exposure effects on red grape

quality were studied by *Haselgrove et al., (2000*) in Australia. They noted a detrimental effect of high exposure. *Bergquist et al. (2001*) found in the Central San Joaquin Valley of California that increased exposure was only beneficial on the north (shady) side of the canopy, but not on the hotter side. *Spayd et al. (2002)* finally separated heat from sunlight effects on grape bunches in Prosser, Washington, whereby temperature of Merlot berries were measured with thermocouples and related to their exposure or cover under foliage. In that study, TA, pH and colour was higher in east exposed than in west exposed bunches. Veraison to harvest degree hours were similar for both exposures but hours above 35^{o}C were considered the crucial factors which were 23 and 9 times higher in west-exposed bunches than in east-exposed bunches in 1999 and 2000 respectively.

This information was the basis for the NE VIC "Regional Innovation and Technology Adoption" project on 25 Shiraz vineyards in 2004/5 and 2005/6 (*Winter et al., 2007*) where cheap and easy to use data loggers were introduced to monitor bunchzone temperatures. Due to the large amount of vineyards studied, it could be observed in both years that those grapes with low bunch heat loads in the afternoon and good warm-up in the morning had better anthocyanin and total phenolic values than those with high heat loads in the afternoon. When the young wines were assessed it became again clear that heatloads (even in a cool area) produce jam and black olive aromas and cold bunchzones may lead to herbaceous and white pepper aromas. In the cool year of 2005 the best wine scores were obtained between 23,000 and 28,000 degree hours above 0^{o}C (Fig. 10). Wines which did not score well had, in this group, over-extracted seeds or petioles in the crush. In the hot year 2006 the best wine scores were obtained between 20,000 and 26,000 degree hours above 0^{o}C. Wines which did not achieve good scores in this bracket came from water stressed vineyards.

In the RITA study of Yarra Valley and Mornington Peninsula Pinot noir vineyards in 2005/06 (*Winter et al. 2006*) the Yarra valley Pinot noir grape and wine analysis showed a similarity to the inland Shiraz patterns, - namely heatloads proved to be detrimental to grape and wine quality. Better wines were from vineyards with high tannin softness which was in turn achieved with more hours in the beneficial bracket of 15-26C. Wine scores were better with more cumulative degree h which came about by warmer sites (no excessive cold nights), good canopy management (no heatloads) and appropriate hangtime (in good conditions). Results from the MP vines and wines were not following this pattern, and it was considered that a second year was needed in the MP to investigate the effect of bunchzone temperatures on grape and wine quality.

This year, cumulative deg hours from veraison to harvest were on average less than last year due to shorter hangtimes, (17,000-25,000). Harvest decisions were often made due to acid loss and fast sugar accumulation which were assessed by the winemakers through berry sensory testing. Some vineyards used leaf plucking to increase morning sun exposure which contributed to a higher average degree h figure and more time in the beneficial bracket of 15-26C than in the previous year. Average degree hours (total divided through hangtime) were in all but one bunchzone higher than 500 and warmer than last year, which reflects a warmer year but also different canopy and interrow management. Grapes spent more hours in the beneficial bracket than last year. Heatloads (degree h above 35C) were unrelated to last year"s due to different hangtime and management. Night temperatures had only a third of the cold hours (below 15C) than last year.

There was no correlation between bunchzone temperatures and grape and wine characteristics as too many factors may also play a role. However it may be of interest to look at a few paired-correlations that may elucidate the benefit of bunchzone temperature monitoring and leaf cover manipulation to better be able to produce grapes for a certain purpose.

Baumé: With very warm ripening conditions as experienced in the MP last year sugar loading was faster and unrelated to active leaf area, however slower with a large number of growing shot tips. Trimming less could be a way to slow down sugar accumulation to facilitate a better harmony between fast Baumé increase, and phenolic ripening which is slower.

TA: From veraison onwards grapes have no access to their own sugar and as a result utilise malic acid as an energy source - mainly at night. In this warmer year, TA was lower than last year and the fastest TA depletion occurred in bunchzones that had the lowest number of hours below 15C. This was also observed in 2006. Cool nights preserve acids and this is could be the reason for the European idea that a large variation between night and day temperatures leads to good wine (whereby in the past high day temperatures were mild compared to now in Europe with the onset of global warming). In the Mornington Peninsula for the future cool sites may have a potential to make excellent wines provided the morning warm-up is ensured and heatloads with sunburn in the afternoons are avoided. Malic acid decomposition happens at night and is faster with warmer nights. The values reflected the warm conditions of the season.

Colour is a quality trait that is of interest for the winemakers, in particular in Pinot noir where in the last year in both regions high wine scores were amongst other traits also related to good colour. Colour formation has been proven to be negatively affected by overcropping, poor nutritional status and water stress. Data about those parameters are missing in this benchmarking study but assessments of canopy condition provide an overview of vine health status. Bunchzone temperatures alone cannot be used for a cause and effect relationship with colour, although since the late 1990"s it had been proven that colour formation and loss is very much influenced by heat *(Haselgrove et al., 2000, Tarara et al. 2000, Spayd et al. 2002*). Last year in the MP, a correlation of colour and average degree h above 26C may have appeared to be present with lower grape colour in cooler bunchzones (except those with shrivelled berries) and in large berries, but this year bunchzones were all slightly warmer so no relationship to cold did appear. *Cortell et al., (2006)* and *Ristic et al (2007)* measured lower colour in grapes and wine with low exposure, *Cortell et al* correlated it to patches of high vigour in the vineyard with excessive bunchzone shading. In our study degree of colour formation was independent of leaf cover at veraison or harvest. In hotter inland vineyards dappled light on the hot side of the canopy is needed to provide lower temperatures that preserve colour (*Winter et al., 2007*), however average heatloads per ripening phase in the Mornington Peninsula do not seem to warrant this. In 05/06 the sum of heatloads during ripening was on average only one fifth of those experienced in NE Victoria and one third of those in the Yarra Valley. Thus the MP vineyards may more often experience a lack of warmth than heatloads. In fact in 05/06 and 06/07 slower colour formation per day of hangtime was noted with bunchzones showing many hours below 15C. Early warm-up of bunchzones can be achieved by leaf plucking on the E or S side of the bunchzone well before veraison; this provided better colour and less degree h below 15C. Exposure to the N and W had no influence as this is not the side for early warm-up.

Total phenolics (also called flavonoids) include proanthocyanins or condensed tannins**,** hydroxycinnamates, flavonols and anthocyanins, but only the latter are synthesised after veraison (*Downey et al 2003 a,b*).
Phenolics are very important for the colour and astringency (or „texture") of red wine, contribute to grape and wine flavour and aroma, and are the main substrates for juice and wine oxidation. Phenolics are produced inside the berry from the amino acid phenylalanine, and most of them (except tannins and hydroxycinnamates) are stored in the form of glycosides (i.e. bound to a sugar molecule, generally glucose). Anthocyanins are responsible for the colour of red grapes, and their accumulation in the skin starts at veraison. The relative proportion of the various anthocyanins depends on the variety, and some varieties (e.g. Cabernet Sauvignon) accumulate pigments to much higher concentrations than other varieties (e.g. Pinot noir). The type and quantities of the different pigments influence intensity, hue, and stability of wine colour.
Tannins are the major flavonoids (by mass) in berries and are composed of different molecules in skins vs seeds. If whole berries are ground up as in this study (data from peeled frozen grapes are very expensive), components from seeds and skins are measured in the extract. Seed tannins become less extractable during ripening and skin tannins become more extractable (in brittle ripe skins) – ideally one would like to have few

unripe seed tannins in a berry extract and many ripe skin tannins (*Ribereau-Gayon et al., 2000*). With the high amount of unripe seeds seen in this study, a high level of total phenolics can be deceiving as they may consist of many unripe seed and few ripe skin phenolics. Consequently, the results must be treated with caution and the BSA results which differentiate seeds and skins must be consulted. In this year (except for a group with high total phenolics/day in low average bunch warmth eg 9,15,10 with cold nights but long hangtimes) there could be a trend assumed between warmer bunchzones and better phenolic ripeness. Higher total phenolics at harvest could, -as with colour-, be related to lower total hours below 15^{o}C. However in contrast to colour, optimal values for phenolics resulted from plucking to 0.8 leaf layers in the W and N side of the vine, whereas opening the canopy to the east had less of an effect. As described in *Ristic et al. (2007)* tannins seem to need more warmth to ripen.

Flavonols (glycosides of quercetin and related compounds) are accumulated in the skin throughout berry development and act as „sunscreen" protecting the berry from harmful ultraviolet radiation. They are potentially important in co-pigmentation of anthocyanins. The majority are formed in response to UV light well before veraison. As they have a potential role in human health and in wine stability inhibiting the oxidation of some phenolic compounds and influencing copigmentation (*Price et al., 1995*), good exposure before veraison will ensure lower vulnerability for sunburn and higher values in the grape extracts. Flavonol concentrations in grapes of the MP tended to be higher from bunches with lower leaf layers in the N and W at veraison (in contrast to colour, leaf layers E and S did not show any trend of an effect on flavonols). Leaf layers N and W measured at harvest were lower in some vineyards due to desiccation and drought or plucking and Flavonols can be degraded by heat after veraison (*Price et al., 1995*), this may explain lower values in bunchzones with plucked or desiccated leaves.
In summary, as the relatively short heatloads in the MP do not seem to be to damaging to colour in grapes provided they have grown under optimum water and nutrient conditions, 0.8-1 leaf layer bunchzones well before veraison may be beneficial for all flavonoids (or phenolics) in grapes.

Tannins are the second class of oenologically important phenolics in addition to anthocyanins. They are responsible for the „drying" or astringent taste sensation of grapes and wine, because they bind to and precipitate proteins (e.g. salivary proteins). Tannins are accumulated in the skin and seed of both red and white grapes. They are the true polyphenols and are composed of chains of one to over 80 almost identical subunits. The grapes" tannin content increases during ripening, probably due to incorporation of anthocyanins, and varies widely between varieties.

Wine Anthocyanins: There is not necessarily a straight relationship between anthocyanins in grapes and colour of wine due to copigmentation in the winemaking process (*Boulton, 2002*). In the present study there was a slight relationship between colour in grapes and in wine, and a distinct relationship between sugar in grapes and alcohol in wine. The 520 nm reading relates to red pigment and the 420 nm to brown pigments thus A520+A420 gives colour intensity (density). The colour intensity scores delivered by the judges related quite well to the chemical measurements. A420/A520 is an indication of the hue. The smaller the number the better for a young red wine, as there should be little brown pigment. The three wines with lower scores had high ratios of brown to red.
Hydroxycinnamates (such as caffeic, coumaric, and ferulic acids) are bound to tartaric acid and are accumulated in the berry flesh after bloom, but decrease during ripening. These compounds can be converted during fermentation to volatile phenols (such as ethyl or vinyl guaiacol and eugenol), which at low concentrations smell „smoky", „woody", „leathery". However, at higher concentrations they become unpleasantly „pharmaceutical" or „medicinal" at the expense of varietal fruit aroma. The concentration of hydroxycinnamates varies between vineyards and the information may help with winemaking practice.

Wine scores, mouthfeel and aromas

This year most wines were well made and many of them achieved better scores. Bunchzone temperatures were on average higher, not only due to a warmer year but also due to leaf plucking and in some cases leaf loss due to desiccation. Some wines may have improved from warmer bunchzone conditions. In particular in a cooler year the Mornington Peninsula growers may need to pay attention to bunch exposure in particular to the beneficial morning sun. The effect of heatloads was not clear due to the low number of vineyards experiencing high heat summations (compared to inland grapegrowing areas). Neither cumulative nor average degree h below 15C correlated with wine score in this year as all vineyards experienced faster than desired acid loss through warmer nights, the vineyards in colder spots lost acid by hangtime.

Much more striking was the relationship of growing practices to wine quality. Higher wine scores were associated with grapes from differentially exposed (av. 0.8 leaves N or W, plucked E) bunchzones on balanced (15-25 cm2/g) vines with early lignified canes and a high ratio of young to active leaves and many growing shoot tips. This is in accordance with work done on grapegrowing practices in Pinot noir (see above) and deserves a further year of observation – provided grapes are maintained unshrivelled and unraisined which is a prerequisite for some clues about vine balance and fruit exposure effects on grape and wine quality . In the present study ripe, colourful unshrivelled grapes with good acid were a prerequisite for good wine scores.

Wine sensory traits are important to know for the participants but as a group there was not much statistical correlation to wine score except fruit aroma and to a lesser degree colour, the absence of bitter and vegetal aromas and the presence of good tannins and body.

Wine sensory traits could not all be pair correlated with all growing conditions. Winemaking also has an influence as many flavours and aromas are only released from precursors during the winemaking process.

From the literature (summarised in *Winter 2000*) it is known that bunch exposure before veraison leads to good carotenoid formation in berries which are antioxidants, “sunscreens” and flavour precursors for peach and violet aromas. These aromas are very heat sensitive. This year showed equal or lower floral aromas in the wine as expected in a hotter year. Many wines were less green - a year with less rain led to better seed lignification (although still not fully ripe) and most likely to faster IBMP decline which is not only related to better bunch exposure, warmer night temperatures but also to lower soil moisture (see *Winter 2003*).

Fruity ratings in wine play a large role for wine assessment and the relationship to growing conditions is not easy to assess as the winemaking plays also a big role (yeasts, extraction time and temperature). There was not a relationship between cumulative degree hours in the bunchzones and fruitiness (as there was no real heatloads compared to inland vineyards where nice fruit precursors get fried to become jam fruit precursors) but from a comparison of last and this year it can be seen that early harvest (4 and 9) will prevent fruitiness. Vine balance is important but there is no indication that dropping half of the crop will increase fruitiness in wine.

Tannin softness in wine was better from grapes with maturer skins (assessed by BSA) but the negative influence of unripe seeds when over-extracted must be taken into account. Tannin quantity is determined before veraison (*Habertson et al 2002*) and tannin “ripening” to softness happens after veraison – research is still under way to determine all important influencing factors for tannin ripening – one of which is soil moisture, one other temperature. As far as is known (*Ristic et al. 2007*) tannins like it hot, but colour and delicate aromas like it moderate. It is important to have precise fruit specifications for each wine style and this study may help communication between grapegrowing and winemaking to end up with the desired (and well selling!) Pinot noir wine style for each of the participants of this Mornington Peninsula study.

Conclusions / Recommendations

Benchmarking studies are of great value to a region as they enable grapegrowers and winemakers to get guidance on measurements they can do themselves, get an independent opinion about their vines and wines and lead to a cohesion within the group that may facilitate collaboration.

For the Mornington Peninsula Pinot noir growers these 2 years of study have revealed the following:
Vineyard microclimates are likely to change with less or varied rainfall and warmer temperatures compared to the long term average.

- Training of viticulturists in the assessment of plant stress symptoms would be highly advisable before maybe embarking as a group on the purchase of a thermal camera.
- Records of rainfall and quantity of irrigation must be included into further benchmarking studies.

It has been shown that the dataloggger measurement of bunchzone temperatures is feasible and affordable and presents an indispensable tool to manipulate canopy and interrow conditions which may affect bunch temperatures thus and fruit quality.

- The insertion of several data loggers would make measurements more precise.
- Recordings of exposure to light pre veraison may give an estimate of phenolic and aroma compound formation potential.

Vineyard soils are crucial components of the grapegrowing environment. Their texture, nutrient content and amount of organic matter has an important influence on plant and grape nutrient and water supply. It is necessary to not just know “irrigated or not” but how much water is available at crucial plant stages.
Soils often show small scale variations which have a bearing on the quality of the fruit over the whole block. These zonal variations may be alleviated with differential management or harvest timing.

- Further studies may well include soil descriptions for the participating vineyards.
- Soil moisture measurements all season should be recorded for future studies.
- EM 38 soil maps would greatly enhance information on vineyard variability.

Vine data gave viticulturists a better understanding of their canopies and vine balances and enabled a comparison to other vine management practices in the region.
A number of growers changed practices between year 1 and 2, mainly opening up the fruit zone to the east, changing trimming habits or improving water supply (less shrivelled and raisined grapes despite a hotter season).

- The importance of trimming shown this year requires another year to better determine the value of laterals.
- Shoot thinning practices have not been assessed and may be of importance.
- Petiole analysis for N could be part of further studies.

Grapes have been analysed chemically and some correlations were attempted between growing practices and grape chemistry. These measurements should be treated with caution:

- Berry chemistry at harvest is influenced by harvest date and growing conditions. Only chemistry per day of hangtime allows a physiological comparison between vineyards.
- Zonal sampling according to Precision Viticulture principles could improve outcomes
- TA when analysed from frozen berries will be lower than natural.
- Malic acid reflected the warmness of the nights – curve of decomposition done by growers with test sticks would be helpful.
- Colour in grapes may not correlate with colour in wine due to copigmentation – colour chemistry is only in inland regions a predictor for quality.

- Total Phenolics assessed from a ground up mix of seeds and skins will not tell much about wine phenolic potential. Samples without seeds will give precise data.
- Tannin quantity is not tannin quality. Phenolic maturity of skins can be studied comparing the extractability at ph1 and 3.5 (*Ribereau-Gayon et al., 2000*).
- Chemicals in berries which play a crucial role in wine stability (eg grape derived gluthation, ascorbic acid) and for copigmentation were not assessed.

Berries have been assessed by the approved method of BSA and important findings have emerged in both years which help grapegrowers and winemakers to make harvest decisions and stream grapes into winemaking modifications:

- Sugar to acid balance will be increasingly more important with more warm nights which decompose acid.
- Decline in herbaceousness is not only a measure of the progress of ripening but also tells something about the hormonal situation of the plant, seems to be not connected to daytime temperatures but rather to night-time malic acid decline.
- Rise of "pulp aromas" can be observed and used for harvest decisions, but is uncorrelated to fruity scores in wine.
- Jammy aromas must be detected quickly in particular under hot conditions, high exposure and drought.
- Sweetness vs fruity sensations will play a big role as sugar from active leaves (in the presence of few laterals) will be in excess with few cloudy das and aroma will be low with lack of water and high exposure.
- Tannin softness of skins was slightly related to tannin softness in wines but independent of irrigation practice – as seed tannins also play a role in wine.
- Decisions about bunch exposure are crucial – in warm years high exposure will favour tannin softness and may affect colour and aroma. In cold years exposure will be beneficial for all BSA traits. Exposure to the east is never wrong.
- Seed ripeness may not be achieved under drought and short hangtimes and may be disregarded for harvest decisions with winemaking adapting to unripe seeds to get the benefit of fresh fruit
- A high amount of shrivelled and raisined berries like in 06 will mask all correlations that could be drawn between growing practice, microclimate and grape quality.
- Group sessions before each season to refresh BSA skills and assess sensitivities to sugar acid balances are recommended as there is palate fatigue for BSA!

Wines

Information on wine chemistry can help to make better wine next time.

- Information on winemaking and yeast strain would be of value for next tome.

The young wines were excellent and not hard to judge this year. Wine quality was this year highly correlated to fruitiness, and also influenced by colour, tannins, body and the absence of bitterness and vegetal aromas.

- A third year of observation is needed to confirm these findings
- Vineyard management and wine making practices could in the future focus on those important traits.
- Colour in grapes was high but only slightly correlated to colour in wine. Colour in wine showed a trend with winescore however high colour does not guarantee high wine scores. Colour loss through heatloads is probably less of a problem in well managed MP vineyards
- The sensation of tannins (extract) is higher than last year, with quite a range of values and of relative importance to the wine score.
- Tannin softness (texture) had a low correlation to wine score. This unexpected finding should be investigated for another season. Tannin softness could be predicted with BSA.

- Some green characters may be attributed to neighbouring trees. Tree leaf volatile aromas can travel to the vineyard in hot years and settle on grape wax layers. Chemical analysis may be warranted in these vineyards.
- Bitterness is to be avoided for high wine scores. Some bitterness was related to the extraction of unripe seeds. Winemaking practice should take BSA into consideration.
- Low vegetal scores were important for good wine scores. Vegetal in this study referred to beetroot, celery, and rhubarb and was felt hard to score. It should next year be termed as “vegetable”.
- Body scores were higher than last year with a wide range but many wines within average values and satisfactory contribution to wine quality. High body scores cannot be reached with low Baumé in grapes.
- Disclosure of winemaking practices is required to close the link between grapegrowing and wine quality.

Interesting relationships between leaf area and type, bunch exposure and wine score have emerged.

- Water relations measurements are required as water and nutrients have such a large bearing on vine hormonal balance, vigour, grape quality and wine quality.
- Shoot thinning and trimming may need to be recorded in more detail.
- Time of plucking may additionally be recorded in the future.

Harvest decisions were this year mainly based on sugar/acid balance due to high night-time temperatures

- Growing more laterals may divert sugar from bunches allowing longer hang times.
- Frequent BSA before harvest would be of advantage to determine the onset of undesirable acid loss.

The good cross section of vineyards, grapes and wines showed similarities from which regional styles can be described. The large amount of individual data can be used to better understand and modify vineyard and winemaking practices to improve grape and wine quality.

Communication between participants was enhanced in group meetings and a forum in which all wines were blind tasted by all participants.

The participants will benefit from a third year of similar studies.

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Disclaimer

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APPENDIX

Table 1: Vineyard characteristics sorted by vineyard code.

Pinot noir vineyards Mornington Peninsula 2007

Code	Soil type	Slope %	Aspect	Altitude (m above sea level)	vine age	Trellis Type	Row orientation	Row spacing m	Vine spacing m	Pruning Method	Clone	Irrigation before verais.	Irrigation after verais.	yield (t/ha)
1	loam over clay	5	nw	65	12	vsp	ew	2.6	1.5	c	mv6	n	n	4.2
2		5	e	70	12	vsp	ew	3.0	1.5	s	mv6	n	y	4.7
3		4	n	50	9	vsp	ns	2.7	1.5	s	mv6	y	y	3.9
4		5	n	33	8	vsp	ns	2.4	1.5	s	mv6	y	y	2.4
5	clay loam	2	n	140	10	vsp	ns	3.0	2.0	c	mv6	y	y	1.7
6		5	n	70	10	vsp	ns	2.5	2.0	s	mv6	y	y	3.0
7	red clay loam	3.5	n	75	12	vsp	ns	2.8	1.5	s	mv6	y	y	3.5
8	red clay loam	10	n	72	9	vsp	ns	2.8	2.8	c	mv6	n	n	3.1
9	red degraded basalt	15	n	150	16	vsp	ns	1.0	2.0	c	mv6	n	n	2.5
10	red clay loam - kraznozem	5	e	200	10	vsp	ew	2.7	1.5	c	mv6	n	n	1.4
11	red clay loam	30	ne		9	vsp	ns	2.0	1.8	c	mv6	y	y	2.2
12	red clay loam	15	n	120	12	vsp	ns	2.5	1.5	c		y	y	2.4
13		5	n	122	9	vsp	ns	2.0	1.5	s	mv6	n	n	2.4
14														
15	red clay loam	10	n	200	22	sh	ns	3.0	1.0	c	mv6	n	n	4.0
16	red clay loam	15	e		17	vsp	ew	3.0	1.5	c/s	mv6	n	y	0.7
17	red clay loam - ferrosol	20	n	140	11	sh	ns	3.0	1.8	s	mv6	n	n	3.5

Tab. 2: Veraison and pre- harvest vineyard assessments

50% VERAISON date of assessment: | **Pre- HARVEST date of assessment:**

Site	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**
M1	**1.00**	**5.4**	**3.2**	**3.5**	**1710**	**12.1**	**39.9**	**2.30**	**1.9**	**1.5**	**4.9**	**0.7**	**1.0**	**4.3**	**2.5**	**4.8**	**0.2**	**sw**	**0.4**	**87.0**	**10.3**
M2	**0.95**	**6.0**	**4.8**	**3.8**	**2063**	**14.5**	**45.7**	**2.18**	**1.7**	**1.5**	**5.0**	**1.4**	**0.5**	**4.9**	**4.6**	**5.0**	**1.0**	**n**	**0.4**	**77.0**	**16.2**
M3	**0.55**	**6.4**	**4.7**	**1.9**	**1725**	**13.0**	**37.1**	**1.83**	**1.8**	**0.7**	**4.9**	**0.8**	**0.8**	**4.6**	**2.9**	**4.5**	**0.4**	**w**	**0.3**	**50.0**	**19.7**
M4	**0.15**	**9.7**	**4.6**	**1.6**	**1968**	**15.8**	**64.7**	**3.24**	**1.6**	**3.7**	**4.0**	**0.8**	**0.3**	**5.0**	**4.9**	**5.0**	**0.8**	**w**	**0.3**	**56.5**	**21.8**
M5	**0.75**	**6.2**	**3.9**	**4.3**	**2060**	**14.4**	**62.2**	**3.40**	**1.9**	**2.6**	**4.8**	**0.6**	**1.0**	**5.0**	**2.6**	**4.6**	**0.4**	**e**	**0.3**	**50.0**	**21.7**
M6	**0.65**	**7.3**	**4.9**	**3.7**	**2205**	**15.9**	**62.8**	**2.90**	**1.6**	**1.7**	**4.6**	**0.9**	**1.4**	**5.0**	**3.9**	**4.7**	**0.5**	**w**	**0.5**	**72.0**	**19.1**
M7	**0.25**	**10.2**	**6.5**	**2.3**	**2445**	**19.0**	**75.1**	**3.00**	**1.5**	**3.0**	**4.0**	**1.1**	**1.2**	**5.0**	**4.6**	**5.0**	**1.2**	**w**	**1.1**	**70.0**	**24.1**
M8	**0.35**	**6.7**	**3.0**	**0.4**	**1188**	**10.0**	**42.1**	**3.22**	**1.4**	**1.1**	**3.8**	**0.8**	**0.9**	**4.4**	**3.9**	**4.4**	**0.9**	**w**	**0.4**	**48.0**	**18.3**
M9	**0.80**	**6.1**	**8.4**	**5.0**	**2863**	**19.5**	**63.6**	**2.27**	**1.7**	**4.4**	**3.4**	**1.7**	**1.6**	**5.0**	**3.5**	**4.8**	**0.9**	**w**	**0.8**	**63.0**	**26.7**
M10	**0.85**	**6.5**	**6.3**	**2.3**	**2033**	**15.0**	**45.8**	**2.03**	**1.9**	**1.4**	**3.2**	**1.1**	**0.2**	**4.9**	**3.7**	**4.9**	**0.2**	**n**	**0.1**	**51.0**	**21.0**
M11	**0.45**	**9.3**	**4.9**	**1.4**	**1945**	**15.6**	**58.1**	**2.81**	**1.8**	**2.1**	**3.9**	**0.7**	**0.7**	**4.9**	**4.3**	**4.9**	**0.7**	**w**	**0.7**	**49.0**	**22.7**
M12	**0.25**	**9.6**	**4.9**	**0.5**	**1785**	**15.0**	**57.5**	**2.91**	**1.8**	**2.2**	**2.8**	**0.9**	**0.1**	**4.4**	**2.3**	**4.7**		**w**		**55.0**	**18.5**
M13	**0.65**	**9.0**	**7.1**	**0.4**	**2040**	**16.5**	**62.5**	**2.75**	**1.8**	**1.4**	**3.7**	**0.5**	**0.6**	**5.0**	**4.5**	**5.0**		**w**			
14																					
M15	**0.25**	**11.2**	**3.4**	**0.5**	**1723**	**15.1**	**60.6**	**3.45**	**1.8**	**3.8**	**2.1**	**0.9**	**0.3**	**4.9**	**4.6**	**5.0**	**1.0**	**w**	**0.3**	**120.0**	**8.0**
M16	**0.95**	**12.4**	**5.6**	**1.1**	**2278**	**19.0**	**66.8**	**2.49**	**1.4**	**1.8**	**3.0**	**0.9**	**1.2**	**5.0**	**2.4**	**4.8**	**0.2**	**n**	**0.1**	**51.0**	**31.9**
M17	**0.20**	**9.2**	**3.5**	**0.6**	**1560**	**13.3**	**37.4**	**1.89**	**1.1**	**0.8**	**4.2**	**0.9**	**0.5**	**4.3**	**2.7**	**4.2**		**w**		**51.4**	**27.6**
Av.07	0.57	8.2	5.0	2.1	1974	15.2	55.1	2.7	1.6	2.1	3.9	0.9	0.7	4.8	3.6	4.8	0.6		0.4	63.4	20.5
	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	.	Back faces what direction?	5=green 4=pale green 3 =yellowing 2=yell/brown 1 = absent				direction		from fruit assessment	leaf area/g fruit wt
Av 06	0.80	6.5	4.3	2.6	1824	13.5	44.0	2.3	1.6	1.2	3.9	0.9	0.7	4.7	4.0	4.6	0.6		0.5	90.4	13.3

Tab 3: Bunchzone temperatures Mornington Peninsula 2006/07 compared to 05/06

Vineyard Code	Logger start	Logger fiish	07 Logger runtime	06 Logger runtime	07 Ver-Ha cumm. degree hours above 0°C	06 Ver-Ha cumm. degree hours above 0°C	07 Average degree hours above 0	06 Average degree hours above 0	07 Ver-Ha degree hours above 35 °C	06 Ver-Ha degree hours above 35 °C	07 Ver-Ha degree hours above 26 °C	06 Ver-Ha degree hours above 26 °C	07 Ver-Ha degree hours below 15°C	06 Ver-Ha degree hours below 15°C	07 % of time in bene ficial bracket	06 % of time in bene ficial bracket	07 Ver-Ha degree hours between 15 and 26 °C	07 Average degree hours between 15 and 26 °C
M1	3.2.	5.3.	30	45	16,639	23,038	555	512	118	96	923	1193	71	388	97.0	93.1	16,133	538
M2	1.2.	9.3.	40	45	18,826		471		62		925		125		99.7		18,764	469
M3	1.2.	5.3.	31	46	18,101	19,779	584	494	321	108	1684	894	47	561	95.1	92.6	17,219	555
M4	1.2.	9.3.	35	54	19,227	19,614	549	490	194	154	1265	1039	139	717	95.3	91.0	18,316	523
M5	1.2.	14.3.	32	57	20,533	24,929	642	489	69	292	858	1519	256	746	96.0	90.9	19,718	616
M6	1.2.	14.3.	40	45	21,524	21,710	538	493	142	171	1308	1116	236	577	96.7	92.2	20,805	520
M7	1.2.	9.3.	35	54	18,127	20,531	518	467	206	46	624	553	131	414	96.6	95.3	17,507	500
M8	1.2.	10.3.	36	44	18,980	20,794	527	473	50	31	698	549	112	425	97.5	95.3	18,505	514
M9	10.2.	23.3.	41	68	19,746	24,201	482	440	61	33	779	662	530	1355	92.8	91.7	18,330	447
M10	10.2.	19.3.	36	60	18,242	22,121	507	461	31	202	650	1124	237	936	94.7	90.7	17,275	480
M11				51		21,826		455		8		487		618		94.9		
M12	9.2.	14.3.	33	48	16,971	21,587	514	480	75	258	852	1426	195	756	95.1	89.9	16,140	489
M13	10.2.	14.3.	32	35	16,625	15,402	520	467	60	24	799	441	150	403	97.2	94.5	16,162	505
14				49		19,863		462		32		589		560		94.2		
M15	1.2.	23.3.	49	67	24,655	26,364	503	418	34	5	760	470	423	1,799	92.6	91.4	22,822	466
M16	1.2.	14.3.	40	47	20,418	18,896	510	450	28	12	535	399	179	553	97.2	95.0	19,837	496
M17	10.2.	19.3.	36	47	19,204	16,955	533	484	150	159	1227	1007	217	549	96.4	90.8	18,505	514
Av.			36	51	19,188	21,101	530	471	107	102	926	842	203	710	96	93	18,403	509

Tab. 4 Vineyard phenology and Berry sensory assessment 07

Vineyard	Veraison assessment	% veraison	Pre harvest assessment date	Approx. Hangtime	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*	Comments
1	3.2.	80	3.3	29	2.2	2.0	3.0	2.8	2.3	2.0	small berries, 2 with mealy bug, light fresh juice with sour/bitter skins, seeds only have a trace of green.
2	3.2.	80	9.3.	35	2.0	2.7	3.0	3.0	2.7	2.7	clean sample, sugar/acid balance with flavour intensity and ripe skin flavour/tannin.
3	3.2.	80	3.3.	29	2.0	2.2	3.0	3.0	2.3	2.8	clean sample, some raison berries, fresh plum flavours and herbaceous/bitter skins.
4	3.2.	70	9.3.	35	2.8	2.2	3.2	2.7	2.0	2.5	clean sample, varied flavours with low acid, grassy/sour skin tannin.
5	3.2.	40	15.3.	36	3.0	2.5	3.0	3.0	2.3	2.3	clean sample, large bunches, varied berry size, some shrivel, grassy tannins.
6	3.2.	75	15.3.	41	2.8	2.8	3.0	3.0	2.8	2.8	clean, consistent sample, some raisoning, well developed skins with fine tannins.
7	3.2.	70	9.3.	35	3.0	2.5	3.0	3.0	2.0	2.3	small berries, 2 with LBAM, fresh fruity flavour, grassy skins, many undeveloped seeds.
8	3.2.	80	9.3.	35	2.8	2.0	3.0	3.0	2.0	2.3	clean sample, sugar/acid balanced with intense plum aroma,slightly green skins.
9	10.2.	65	23.3.	42	2.8	2.2	3.0	3.0	2.5	2.0	clean sample, tiny bunches, fresh flavours, some raison, grassy skins.
10	10.2.	75	17.3.	36	2.2	2.7	3.0	3.0	2.3	2.0	clean sample, small bunches with fresh flavour, consistent.
11	10.2.	80	23.3.	42	3.0	2.3	3.0	3.0	2.0	2.0	clean sample, small bunches with varied berry size, ripe plum flavour, some showing tough/green skin tannin.
12	10.2.	75	15.3.	34	2.8	2.3	2.5	2.2	2.2	2.2	clean, small bunches, no bloom and some juicing, low acid/sugar, smoky/woody taste, some raisons, unusual.
13	10.2.	95	15.3.	38	2.7	2.3	3.0	3.0	2.5	2.5	clean sample,small bunches, some juicing, ripe dark cherry flavour, low acid with high woody tannin in skins.
14											
15	10.2.	70	23.3.	42	2.2	2.3	2.7	2.7	1.7	2.0	clean sample, large berries in perfect condition with plum/anise flavours, skins green/grassy, minimal shrivel.
16	10.2.	85	15.3.	34	3.0	2.3	3.2	3.2	2.0	2.0	clean, consistent sample, some shrivel, low acid and ripe flavours with some woody/herbal/parsley skin flavour.
17	10.2.	85	17.3.	36	2.3	2.7	3.0	3.0	2.2	2.2	clean, large berries and tight bunches, some shrivel, juicy/ripe/jammy flavours- intense with some spicy/tangy skins.
Av. 07				33	2.6	2.4	3.0	2.9	2.2	2.3	
STD					0.4	0.2	0.2	0.2	0.3	0.3	
Av 06							3.0	3.1	2.3	2.2	

Tab. 5 Mornington Peninsula Pinot Noir 2007 Chemical Analysis

Vineyard	Approx. Hangtime	Shrivel	Av. berry weight (gms)	pH	TA	Malic acid	Brix	Baume	Anthocyanins (/mg berry wt.)	Total Phenolics (AU/mg berry wt.)	Flavonols (/mg berry wt.)	Stalk removal	Berry softness	*Pulp maturity*	*Pulp aroma*	*Skin maturity*	*Seed maturity*
1	29		0.63	3.75	5.7	2.5	22.6	12.6	0.75	1.06	0.32	2.2	2.0	3.0	2.8	2.3	2.0
2	35		0.93	3.72	6.1	3.1	23.7	13.2	0.70	0.92	0.25	2.0	2.7	3.0	3.0	2.7	2.7
3	29		0.75	3.76	5.4	1.8	23.8	13.2	0.85	1.13	0.35	2.0	2.2	3.0	3.0	2.3	2.8
4	35		0.61	3.94	5.7	3.1	20.8	11.6	1.01	1.09	0.37	2.8	2.2	3.2	2.7	2.0	2.5
5	36	some	0.79	3.79	5.7	2.7	23.8	13.2	1.31	1.09	0.43	3.0	2.5	3.0	3.0	2.3	2.3
6	41		0.88	3.65	5.4	2.3	24.6	13.7	1.10	1.19	0.34	2.8	2.8	3.0	3.0	2.8	2.8
7	35		0.84	3.65	6.9	3.3	23.2	12.9	1.11	1.13	0.34	3.0	2.5	3.0	3.0	2.0	2.3
8	35		0.63	3.60	6.6	2.3	23.9	13.3	1.41	1.23	0.38	2.8	2.0	3.0	3.0	2.0	2.3
9	42		0.63	3.79	6.9	3.5	24.0	13.3	0.99	1.19	0.37	2.8	2.2	3.0	3.0	2.5	2.0
10	36		0.66	3.71	6.1	3.1	23.6	13.1	0.82	0.95	0.30	2.2	2.7	3.0	3.0	2.3	2.0
11	42		0.65	3.72	6.5	2.7	24.4	13.6	1.14	1.50	0.46	3.0	2.3	3.0	3.0	2.0	2.0
12	34		0.75	3.70	5.4	3.3	22.7	12.6	1.09	0.85	0.31	2.8	2.3	2.5	2.2	2.2	2.2
13	38		0.80	3.72	5.4	2.7	23.5	13.1	1.25	1.07	0.34	2.7	2.3	3.0	3.0	2.5	2.5
14																	
15	42		0.78	3.68	6.8	3.3	23.4	13.0	1.13	1.43	0.43	2.2	2.3	2.7	2.7	1.7	2.0
16	34	some	0.75	3.73	5.6	3.7	23.2	12.9	1.00	0.91	0.33	3.0	2.3	3.2	3.2	2.0	2.0
17	36	some	0.83	3.75	5.9	3.3	23.4	13.0	0.82	0.97	0.27	2.3	2.7	3.0	3.0	2.2	2.2
Av.07	36		0.7	3.73	6.0	2.9	23.4	13.0	1.03	1.11	0.35	2.6	2.4	3.0	2.9	2.2	2.3
STD			0.1	0.08	0.6	0.5	0.9	0.5	0.2	0.2	0.1	0.4	0.2	0.2	0.2	0.3	0.3
Av 06	42		0.9	3.80	7.1			13.5	0.90					3.0	3.1	2.3	2.2

Averages and standard deviations were calculated for each trait and the outliers above (red) and below average (green) are highlighted.

Tab. 6: Wine Chemistry

Site	WINE Alcohol v/v %	WINE pH	WINE TA (g/L)	WINE K (mg/L)	Anthocyanins mg/L	Total red pigments A 520	Colour Density A520 + A420	Hue Index A420 / A520	Hudroxycinnamates AU	Flavonols A360	Phenolics A280	Tannins g/L	Epicatechin g/L
1	12.3	3.40	6.2	740	268.2	13.9	6.7	0.7	15.3	8.0	40.5	0.36	1.30
2													
3	13.4	3.53	5.9	630	340.6	17.7	9.2	0.7	15.2	7.6	57.2	0.56	2.09
4	13.2	3.69	6.6	600	252.2	13.1	5.2	0.9	13.9	7.2	42.8	0.29	1.00
5	13.4	3.63	5.5	840	403.7	20.7	8.0	0.6	17.5	8.6	52.3	0.39	1.43
6	13.7	3.56	5.6	850	289.3	15.2	6.5	0.7	16.2	8.0	47.1	0.45	1.67
7	13.1	3.65	5.7	750	306.2	15.8	6.0	0.7	12.7	5.9	42.9	0.38	1.38
8	14.2	3.39	6.7	750	418.9	21.6	9.3	0.6	20.2	9.1	54.9	0.47	1.74
9	14.7	3.59	6.2	900	331.6	17.0	6.7	0.6	14.6	6.9	41.8	0.38	1.38
10	13.7	3.51	6.3	550	345.6	17.8	6.5	0.7	11.7	6.5	37.7	0.25	0.84
11	13.5	3.41	6.4	690	289.1	15.3	9.4	0.6	15.5	7.9	50.1	0.93	1.83
12	12.6	3.38	9.2	4200*	374.2	19.2	3.0	1.1	19.5	8.9	94.5	0.29	1.02
13	14.2	3.45	6.3	560	348.1	18.2	8.6	0.6	16.8	7.7	42.6	0.27	0.94
14													
15	13.9	3.51	6.3	710	256.7	13.2	6.4	0.8	12.5	6.0	37.6	0.37	1.35
16	13.2	3.59	5.8	960	244.7	13.2	9.4	0.7	17.2	7.8	52.8	0.54	2.00
17	14.1	3.57	5.7	770	265.1	13.7	4.0	0.8	11.4	6.1	40.3	0.33	1.18

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* Over-sulphured sample

Tab. 7 Synopsis of wine assessments

0=absent, 5= intense

Vineyard Code	Colour	Green	Bitter	Vegetal	Floral	Fruity	Stewed	Raisined	Complex	Acidic	Extract	Texture	Alcohol	Body	"Wine Show" Score	
av1	3.8	4.0	2.0	3.0	3.6	3.2	2.0	1.2	2.6	3.8	3.0	2.8	3.0	2.4	15.5	green , cherry, cypress, cola, floral
av2	4.0	2.0	1.0	1.0	3.0	4.0	3.0	2.0	4.0	3.0	4.0	4.0	4.0	4.0	17.0	ripe, dark cherry/plum, spice,
av3	3.8	1.8	2.2	2.2	2.0	3.6	2.6	1.8	2.4	3.2	4.0	2.2	3.4	3.0	15.6	ripe, firm, cherry, plum, mint.
av4	2.2	3.0	2.4	3.6	2.6	2.6	3.0	1.4	3.2	3.4	2.6	2.6	3.2	2.2	14.0	mulch, straw, fine, floral, vegetal.
av5	4.4	2.6	2.2	2.6	3.0	3.4	2.8	2.4	3.4	3.2	3.8	3.6	3.6	3.6	16.5	ripe, plum, floral, licorice, menthol.
av6	4.2	1.6	2.0	1.8	2.4	3.4	2.6	1.8	3.4	3.4	4.2	4.2	3.0	3.4	15.8	savoury, earthy, firm, oaky, sulphide
av 7	3.0	1.2	1.6	2.4	2.4	3.8	1.4	1.2	2.0	3.4	2.8	3.6	3.0	2.6	16.5	clean, cherry pip, plum, fine, soft.
av8	4.2	2.2	2.4	1.6	2.2	3.2	2.4	2.0	3.8	3.6	4.2	2.4	3.0	3.8	16.7	dark fruit, rich, oaky, firm tannin.
av9	4.0	3.4	2.2	2.8	2.2	3.2	3.4	2.8	2.4	3.4	3.4	3.0	3.8	3.0	15.8	inky, spice, raw, plum, jammy, raspberry.
av10	3.6	3.0	2.4	3.0	2.4	3.8	2.8	1.8	3.2	3.4	3.2	3.0	3.0	3.0	16.0	vegetal, mineral, cherry, leaf, stewed.
av11	4.4	2.6	2.6	2.2	2.2	3.4	2.6	1.6	2.6	3.6	4.4	2.6	2.6	3.4	16.1	sweet plum, fine, cherry, herbal, sulphide.
av12	5.0	1.0	1.0	2.0	2.0	5.0	4.0	2.0	4.0	4.0	5.0	4.0	3.0	5.0	18.0	dense, plum/licorice, rich, hard acid
av13	4.2	2.2	2.2	2.6	2.6	3.6	3.0	1.8	3.4	3.2	3.2	3.2	3.6	3.6	15.4	earthy, leesy, herbal, sweet plum, brett?
14																
av15	4.0	3.0	2.4	3.2	3.2	2.8	2.8	2.2	2.4	3.6	3.8	3.0	3.2	3.2	14.5	soft, floral, mulch, green, quince
av16	5.0	4.4	3.0	3.2	2.0	2.4	3.0	3.0	3.0	3.2	3.2	2.4	3.6	3.2	14.2	dense, chocmint, heavy, green, firm.
av17	2.6	2.2	3.0	2.8	2.4	2.4	1.4	1.2	3.0	3.2	2.4	2.6	3.0	2.2	13.0	mineral, almond, cherry, bacterial, mousy?
average	3.9	2.5	2.2	2.5	2.5	3.4	2.7	1.9	3.1	3.4	3.6	3.1	3.3	3.2	15.7	
STD	0.8	0.9	0.6	0.7	0.5	0.7	0.7	0.5	0.6	0.3	0.7	0.6	0.4	0.7	1.3	
r2	0.3	0.1	0.4	0.4	0.0	0.7	0.0	0.0	0.0	0.1	0.3	0.1	0.0	0.3		
av 06	3.5	2.3	2.0	2.3	2.3	3.1	2.4	1.7	2.8	3.1	3.3	2.8	2.9	2.9		

Wines from vineyard 2 and 12 were assessed by judge 5 only and are therefore not an average score.
Averages and standard deviations were calculated for each trait and the outliers above and below average are highlighted in red.
The r2 values are the statistical correlations with wine score, high fruitiness was significantly correlated and there was a trend with increased colour, the absence of bitterness and vegetal aromas and high tannin extract and body.

Individual judge scores below.

Individual judge scores Pinot noir Mornington Peninsula 07

Vineyard Code	Colour	Green	Bitter	Vegetal	Floral	Fruity	Stewed	Raisined	Complex	Acidic	Extract	Texture	Alcohol	Body	"Wine Show" Score
explanation	density plus hue	leafy, eucalypt mint	sappy, sour, pome granate	beetroot, rhubarb, celery	violets, lavender lillies	strawb., raspberry red cherry	dark plum, quince jelly, licorce	jammy, porty, overripe	mulch, meaty, gamey, spice	crisp, tart, steely	tannin intensity	tannin softness	hot fire	viscosity glycerol	out of 20
1															
j1	4	4	1	2	4	4	2	1	3	4	4	4	3	4	17.0
j2	3	4	1	2	3	2	2	1	1	5	2	2	3	2	15.0
j3	3	3	2	3	4	4	2	1	4	3	2	2	3	2	16.0
j4	5	5	3	4	3	3	3	2	2	4	4	2	3	2	14.5
j5	4	4	3	4	4	3	1	1	3	3	3	4	3	2	15.0
av1	**3.8**	**4.0**	**2.0**	**3.0**	**3.6**	**3.2**	**2.0**	**1.2**	**2.6**	**3.8**	**3.0**	**2.8**	**3.0**	**2.4**	**15.5**
2															
j5	4.0	2.0	1.0	1.0	3.0	4.0	3.0	2.0	4.0	3.0	4.0	4.0	4.0	4.0	17.0
3															
j1	4	1	2	2	2	4	2	2	2	3	3	3	4	3	16.0
j2	4	1	1	3	2	3	2	2	3	4	5	2	3	3	15.0
j3	3	2	2	2	2	4	3	1	2	3	4	2	4	3	16.0
j4	4	3	4	2	2	4	2	1	2	3	4	1	3	2	16.0
j5	4	2	2	2	2	3	4	3	3	3	4	3	3	4	15.0
av3	**3.8**	**1.8**	**2.2**	**2.2**	**2.0**	**3.6**	**2.6**	**1.8**	**2.4**	**3.2**	**4.0**	**2.2**	**3.4**	**3.0**	**15.6**
4															
j1	2	3	2	3	4	4	1	1	2	3	3	3	3	3	14.0
j2	2	4	2	4	1	1	4	1	4	4	1	2	3	1	13.0
j3	3	1	1	1	3	3	4	1	3	3	3	2	4	3	15.0
j4	2	4	4	5	1	2	2	2	3	4	4	2	3	2	14.0
j5	2	3	3	5	4	3	4	2	4	3	2	4	3	2	14.0
av4	**2.2**	**3.0**	**2.4**	**3.6**	**2.6**	**2.6**	**3.0**	**1.4**	**3.2**	**3.4**	**2.6**	**2.6**	**3.2**	**2.2**	**14.0**
5															
j1	4	2	2	2	4	4	1	1	3	3	3	4	3	4	16.5
j2	5	4	4	4	1	1	3	4	4	4	4	1	4	2	14.0
j3	4	3	2	3	3	3	2	1	2	3	4	3	4	4	17.0
j4	4	3	2	2	4	4	3	2	4	3	4	5	4	4	17.0
j5	5	1	1	2	3	5	5	4	4	3	4	5	3	4	18.0
av5	**4.4**	**2.6**	**2.2**	**2.6**	**3.0**	**3.4**	**2.8**	**2.4**	**3.4**	**3.2**	**3.8**	**3.6**	**3.6**	**3.6**	**16.5**
6															
j1	4	1	1	2	4	5	2	2	3	4	4	5	3	4	17.0
j2	5	2	1	2	1	1	1	2	1	4	5	2	2	2	13.0
j3	5	1	3	1	1	2	4	1	4	3	4	4	3	2	15.0
j4	2	3	3	2	4	4	2	2	4	3	4	5	4	4	16.0
j5	5	1	2	2	2	5	4	2	5	3	4	5	3	5	18.0
av6	**4.2**	**1.6**	**2.0**	**1.8**	**2.4**	**3.4**	**2.6**	**1.8**	**3.4**	**3.4**	**4.2**	**4.2**	**3.0**	**3.4**	**15.8**
7															
j1	3	1	1	2	2	3	1	1	1	4	3	3	3	3	17.0
j2	3	1	1	3	3	3	1	1	2	4	3	4	3	3	16.0
j3	3	1	2	2	2	5	1	1	3	3	3	2	3	2	17.0
j4	3	1	2	2	2	4	2	2	2	3	2	4	3	2	16.5
j5	3	2	2	3	3	4	2	1	2	3	3	5	3	3	16.0
av 7	**3.0**	**1.2**	**1.6**	**2.4**	**2.4**	**3.8**	**1.4**	**1.2**	**2.0**	**3.4**	**2.8**	**3.6**	**3.0**	**2.6**	**16.5**
8.0															
j1	4	1	1	1	4	4	1	1	3	3	4	4	3	4	18.0
j2	4	2	4	1	1	1	1	4	4	5	4	1	3	3	14.0
j3	4	3	2	3	2	3	3	1	4	3	3	2	2	3	17.0
j4	4	3	3	2	2	4	3	2	4	4	5	2	3	4	17.5
j5	5	2	2	1	2	4	4	2	4	3	5	3	4	5	17.0
av8	**4.2**	**2.2**	**2.4**	**1.6**	**2.2**	**3.2**	**2.4**	**2.0**	**3.8**	**3.6**	**4.2**	**2.4**	**3.0**	**3.8**	**16.7**

Vineyard Code	Colour	Green	Bitter	Vegetal	Floral	Fruity	Stewed	Raisined	Complex	Acidic	Extract	Texture	Alcohol	Body	"Wine Show" Score
explanation	density plus hue	leafy, eucalypt mint	sappy, sour, pome granate	beetroot, rhubarb, celery	violets, lavender lillies	strawb., raspberry red cherry	dark plum, quince jelly, licorce	jammy, porty, overripe	mulch, meaty, gamey, spice	crisp, tart, steely	tannin intensity	tannin softness	hot fire	viscosity glycerol	out of 20
j1	4	2	2	2	4	4	2	2	3	3	3	4	3	4	16.0
j2	4	4	3	4	1	1	4	5	1	4	2	1	4	1	13.0
j3	4	3	2	4	1	4	2	1	2	3	4	3	4	3	16.0
j4	4	4	3	3	3	3	4	3	2	4	4	4	5	3	16.5
j5	4	4	1	1	2	4	5	3	4	3	4	3	3	4	17.5
av9	**4.0**	**3.4**	**2.2**	**2.8**	**2.2**	**3.2**	**3.4**	**2.8**	**2.4**	**3.4**	**3.4**	**3.0**	**3.8**	**3.0**	**15.8**
10															
j1	4	4	1	1	4	4	1	1	3	3	3	4	3	4	17.0
j2	4	2	4	4	1	4	4	2	2	4	2	2	3	2	15.0
j3	3	3	2	4	1	3	2	1	3	3	2	2	3	2	15.0
j4	3	5	4	3	2	4	3	2	3	4	5	2	3	2	16.0
j5	4	1	1	3	4	4	4	3	5	3	4	5	3	5	17.0
av10	**3.6**	**3.0**	**2.4**	**3.0**	**2.4**	**3.8**	**2.8**	**1.8**	**3.2**	**3.4**	**3.2**	**3.0**	**3.0**	**3.0**	**16.0**
11															
j1	4	2	1	2	4	4	1	1	3	3	5	3	3	4	16.5
j2	4	4	5	2	1	1	1	1	1	5	4	1	2	2	14.0
j3	4	2	2	2	2	4	3	1	3	3	4	3	2	3	16.0
j4	5	4	4	4	2	4	3	3	2	4	5	2	3	3	16.0
j5	5	1	1	1	2	4	5	2	4	3	4	4	3	5	18.0
av11	**4.4**	**2.6**	**2.6**	**2.2**	**2.2**	**3.4**	**2.6**	**1.6**	**2.6**	**3.6**	**4.4**	**2.6**	**2.6**	**3.4**	**16.1**
12.0															
j5	5.0	1.0	1.0	2.0	2.0	5.0	4.0	2.0	4.0	4.0	5.0	4.0	3.0	5.0	18.0
av 12															
13															
j1	4	1	1	2	5	5	1	1	3	3	3	4	3	4	16.5
j2	3	2	4	4	2	2	3	2	3	4	2	2	3	2	14.0
j3	5	3	2	4	2	3	3	1	3	3	3	2	4	3	16.0
j4	4	3	3	2	2	4	3	1	3	4	4	3	5	4	15.5
j5	5	2	1	1	2	4	5	4	5	2	4	5	3	5	15.0
av13	**4.2**	**2.2**	**2.2**	**2.6**	**2.6**	**3.6**	**3.0**	**1.8**	**3.4**	**3.2**	**3.2**	**3.2**	**3.6**	**3.6**	**15.4**
15															
j1	4	2	4	2	3	3	4	4	3	4	4	2	3	4	14.0
j2	4	4	1	3	2	1	2	2	1	4	4	2	3	2	14.0
j3	4	3	2	3	4	3	2	1	2	3	3	3	4	4	15.0
j4	4	4	3	4	2	3	3	2	2	4	4	4	3	2	14.5
j5	4	2	2	4	5	4	3	2	4	3	4	4	3	4	15.0
av15	**4.0**	**3.0**	**2.4**	**3.2**	**3.2**	**2.8**	**2.8**	**2.2**	**2.4**	**3.6**	**3.8**	**3.0**	**3.2**	**3.2**	**14.5**
16															
j1	5	4	3	3	3	3	1	1	3	3	3	3	3	4	14.0
j2	5	5	2	2	1	1	1	5	1	4	2	3	3	2	12.0
j3	5	3	2	3	2	2	4	2	4	3	2	2	4	3	15.0
j4	5	5	4	4	2	4	4	3	2	4	4	2	4	3	15.0
j5	5	5	4	4	2	2	5	4	5	2	5	2	4	4	15.0
av16	**5.0**	**4.4**	**3.0**	**3.2**	**2.0**	**2.4**	**3.0**	**3.0**	**3.0**	**3.2**	**3.2**	**2.4**	**3.6**	**3.2**	**14.2**
17															
j1	3	2	4	3	2	2	1	1	3	3	3	2	3	3	12.0
j2	2	4	4	3	1	1	1	1	2	4	1	2	2	1	12.0
j3	3	1	1	1	3	3	1	1	2	3	2	2	4	2	15.0
j4	3	3	4	3	2	3	2	2	3	3	4	2	3	2	13.0
j5	2	1	2	4	4	3	2	1	5	3	2	5	3	3	13.0
av17	**2.6**	**2.2**	**3.0**	**2.8**	**2.4**	**2.4**	**1.4**	**1.2**	**3.0**	**3.2**	**2.4**	**2.6**	**3.0**	**2.2**	**13.0**