GRAPEVINE PHENOLOGY OF THE MARLBOROUGH REGION, NEW ZEALAND

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Abstract

High resolution temporal and spatial temperature mapping together with phenology models are being used to predict the time and duration of key phenological events of Sauvignon blanc grapevines. The objectives of the research are to: 1) develop models to enable industry to anticipate the consequences of climate variation for phenology within the Marlborough region, and 2) to enable growers to consistently produce fruit of optimum composition for the Marlborough wine style. By combining field measurements of grapevine response, automatic weather station data, improved phenological models, and advanced high-resolution weather prediction models, web-based tools are being developed to help wine-makers adapt to changing conditions so that they can continue to produce high quality wine.

Keywords: Phenology, Sauvignon blanc, Grapevine Flowering Véraison model (GFV), Flowering, Marlborough, New Zealand

1 INTRODUCTION

Over the past 40 years the area of grapevines in Marlborough, New Zealand has increased from the initial plantings in 1973 to approximately 27 000 ha in 2013. Coincident with this increase has been a spread of the planted vineyard area from the central Wairau plains to more inland and coastal areas and to the cooler Awatere valley, 30 km south of the Wairau. Despite the relatively small geographic area (~80% of vineyards are within a circle of 40 km in radius), spatial variations in temperature are apparent, largely reflecting the distance from the sea, altitude and mountainous terrain. Similarly, marked differences in phenology both within and between seasons are observed.

As part of a wider project, mesoscale three-dimensional atmospheric modelling systems are being used to develop high resolution (1 km) temperature maps of the vineyard areas of Marlborough. These temperature maps are being used to predict the timing of key phenological events, in particular flowering, to provide the wine industry with forecast information on potential yield and harvest date.

2 MATERIALS AND METHODS

A network of 37 automatic weather stations (AWS) has been established on vineyards in the Marlborough region (Figure 1). At the same time, flowering and bunch weight data have been collected from replicate plots at each of a number of these sites. Four replicate plots of cane pruned Sauvignon blanc vines were used within each of the vineyards. Each cane was pruned to 10 nodes and one representative cane was chosen in each plot for phenology monitoring and flowering assessment twice per week starting in late November. Flowering progression was assessed at each inflorescence position on the cane, flowering progression taken as the average of all inflorescences. Bunch weight was determined by harvesting four bays of four vines at each site and dividing the total yield by the bunch number.

The phenological observations from four sites collected in 2013 (Table 1) were compared with predictions obtained using the Grapevine Flowering Véraison model (GFV) (Parker et al. (2011) from both AWS data and output from the Weather Research and Forecasting (WRF) model (http://wrf-model.org/index.php).

The original parameterisation in Parker et al. (2013) (base temperature T_b= 0, and start date t_0 = 60th Day of the Year (DOY) in the Northern Hemisphere, 29th August when 1 July = DOY 1 in the Southern Hemisphere, F^*= 1282) was used to estimate flowering date on a regional basis.

Table 1: Phenological and meteorological station site details.

Meteorological station	Phenological site
Brancott (BRA)	Booker (BOK)
Oyster Bay (OYB)	Oyster Bay
Seaview (SEA)	Seaview
Squires (RPC)	Squires

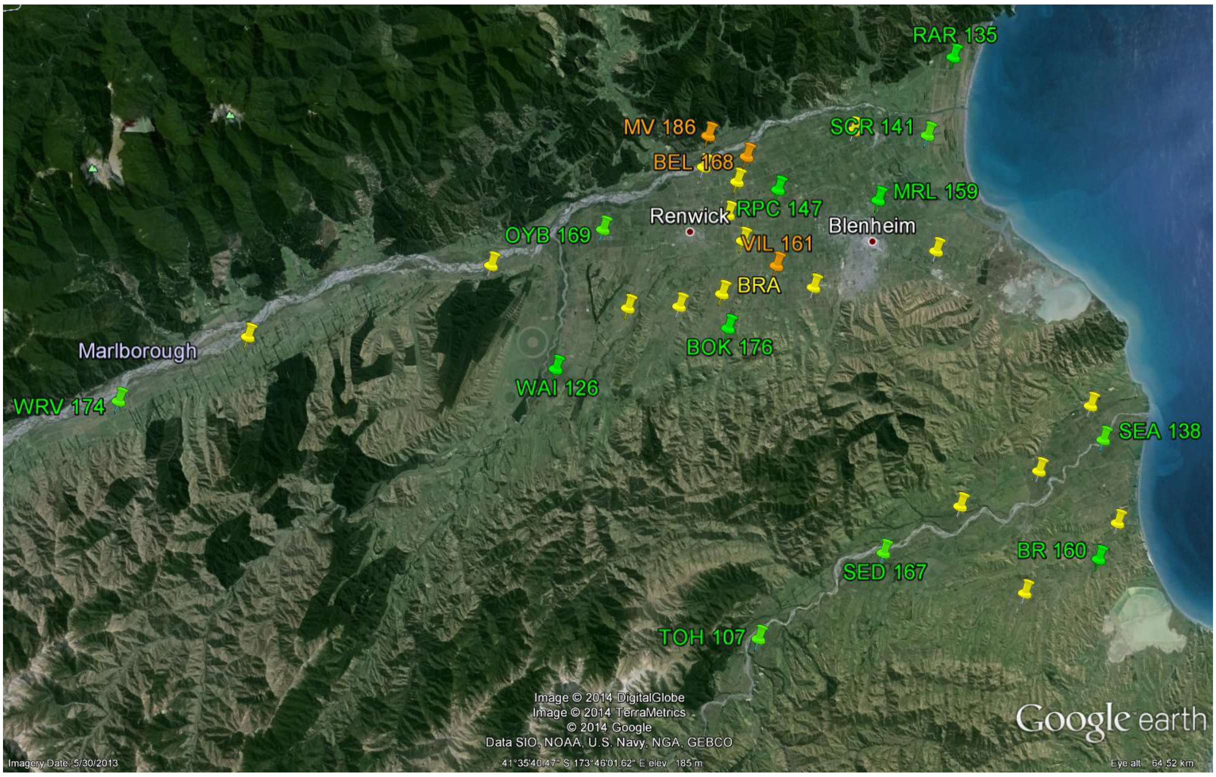

Figure 1: The location of meteorological stations in the Wairau (northern) and Awatere (southern) valleys. Yellow identifiers are temperature only, green identifiers are temperature and bunch weight (value in g indicated by the number) and orange identifiers are bunch weight only.

3 RESULTS AND DISCUSSION

The sites in the central and coastal region of the Wairau valley (RPC, MRL, SCR, OYB, VIL, BOK) flowered first and at approximately the same time (Table 2 and Figure 2). The Awatere valley sites (SEA and SED) and sites further inland on the Wairau valley (WRV and WAI) flowered five to seven days later than those in the central and coastal Wairau valley (Table 2 and Figure 2). The last site to initiate flowering was TOH, which is located in the upper Awatere valley at its western end (furthest site from the coast in the valley). This is also the coolest of all the sites. The duration of flowering at all sites was between eight and ten days. This is a relatively short duration for flowering of Sauvignon blanc in Marlborough and this is a reflection of the warm temperatures that prevailed over the flowering period in 2013.

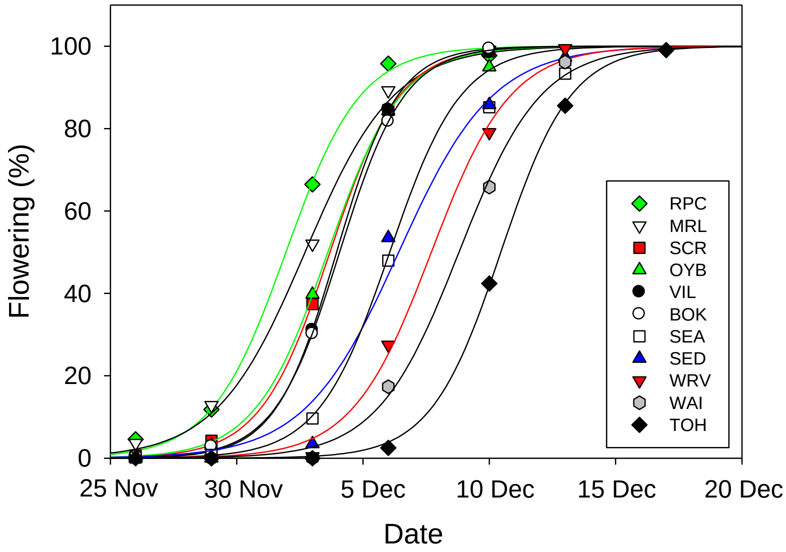

Figure 2: Flowering development recorded at 11 automatic weather station sites in the Marlborough meteorological/phenological network. Sites are ordered from the earliest to reach 10% flowering to the latest. All curves were fitted to the Logistic function, $y = \frac{100}{\left(1+e^{\left(-\frac{(x-m)}{b}\right)}\right)}$, where the value 100 corresponds to the maximum percentage of flowering, *b* corresponds to the rate constant, *m* is the inflection point on the curve, and *x* is the date).

Bunch weights are largely determined by temperatures at flowering (Vasconcelos, et al. 2009). At harvest, bunch weights ranged from 107 to 176 g. In general, (with the exception of WRV, lowest bunch weights coincided with either the later flowering sites of TOH and WAI, or the coastal sites of SEA and RAR (Figure 1 and Table 2). The exception was WRV, which had the second highest bunch weights in the region (Table 2).

Table 2: Site differences in the timing and duration of flowering of Sauvignon blanc, Marlborough. Sites are ordered from the earliest to reach 10% flowering to the latest.

Site	Flowering date (2013)			Duration (time from 10 to 90% flowering)	Mean bunch weight at harvest (g)
	10%	50%	90%		
RPC	28 Nov	2 Dec	5 Dec	10	147
MRL	28 Nov	3 Dec	6 Dec	9	159
SCR	30 Nov	4 Dec	8 Dec	9	141
OYB	30 Nov	4 Dec	9 Dec	10	169
VIL	30 Nov	4 Dec	8 Dec	9	161
BOK	30 Nov	4 Dec	9 Dec	10	176
SEA	3 Dec	6 Dec	12 Dec	10	138
SED	4 Dec	6 Dec	11 Dec	8	167
WRV	4 Dec	8 Dec	12 Dec	9	174
WAI	5 Dec	9 Dec	13 Dec	9	126
TOH	7 Dec	11 Dec	15 Dec	9	107

The Grapevine Flowering Véraison model (GFV) parameterisation for Sauvignon blanc (F^* =1282) (Parker et al. 2013) predicted flowering dates to an acceptable level, with differences between predictions and observations no greater than 3 days (Table 3). As described in Sturman et al. (2014), the Weather Research and Forecasting (WRF) model has been used to determine spatial variability in accumulated growing degree days and the date of flowering across the Marlborough region at 1 km spatial resolution (Figure 3) based on predicted daily air temperatures from 1 September 2013. The WRF model was found to have a slight cold bias which is consistent across the vineyard area. This bias was removed by applying linear regression to the daily modelled and observed temperatures at each site. As can be seen from Table 3, the bias-corrected flowering dates derived from the WRF model were found to be very close to those derived independently from both automatic weather station temperatures and direct observations of flowering dates.

Table 3: Date of flowering compared to dates simulated using the Grapevine Flowering Véraison model for Sauvignon blanc (where t_0 =29th August *Tb*= 0°C and *F =1282), based on automatic weather station data and output data from the Weather Research and Forecasting model.**

Site	Date of flowering	Date predicted by GFV model based on AWS data	GFV/AWS Observed-Predicted (Days)	Date predicted by GFV model based on WRF data	GFV/WRF Observed-Predicted (Days)
BOK	4 Dec	4 Dec	0	3 Dec	1
OYB	4 Dec	6 Dec	-2	3 Dec	1
SEA	6 Dec	3 Dec	3	3 Dec	3
RPC	2 Dec	3 Dec	-1	30Nov/1 Dec	1-2

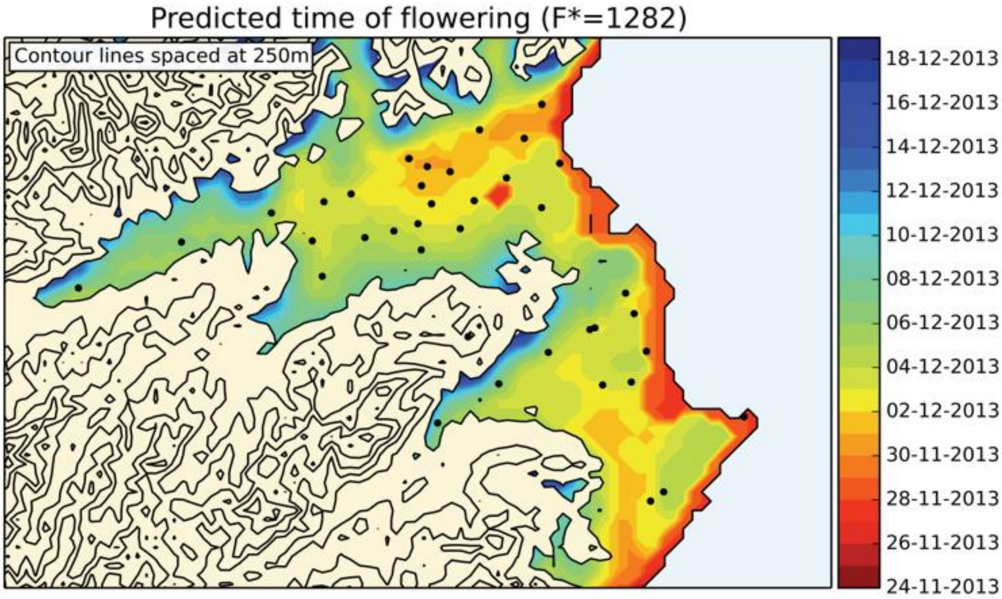

Figure 3: Isochrone map of the date on which accumulated degree day values derived from the Grapevine Flowering Véraison model achieved F* = 1282 across the Marlborough region, based on the Weather Research and Forecasting model output at 1 km spatial resolution.

4 CONCLUSION

Predicting phenology and grapevine yield is valuable to growers, particularly in providing information to make key management decisions, such as whether vine yield needs to be moderated through bunch thinning, and identifying the last date at which agrichemicals can be applied to avoid residue levels in the grape juice. Despite the small size of the Marlborough region, differences in regional temperatures can influence spatial variability of both the timing of, and the temperatures at flowering.

The flowering of Sauvignon blanc (10 to 90% flowering) within the Marlborough vineyard region occurred over an 18 day period in the 2013/14 season. However, the duration of flowering (8 to 10 days) was similar across all the vineyards. In general, later flowering, or sites close to the coast resulted in lighter bunch weights.
Use of bias-corrected temperature data obtained from the WRF model at 1 km resolution was applied to prediction of GFV growing degree day accumulation through the growing season. The parameter F* = 1282, representing heat accumulation required to produce 50% flowering for Sauvignon blanc (F* =1282) (Parker et al.

2013), was then used to determine model-predicted flowering dates. The resulting dates were very close to those derived from both AWS temperatures and direct observation of flowering.

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