Cold hardiness of grapevine buds at the Western Colorado Research Center - Rogers Mesa near Hotchkiss, Colorado, 2013/14.

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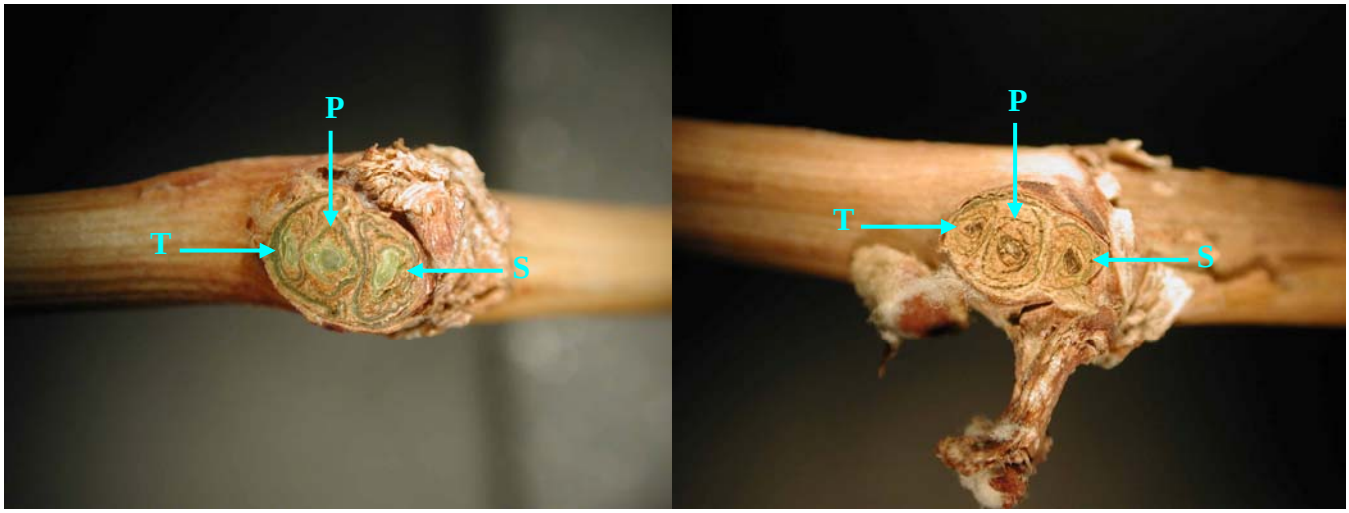
Dormant buds were collected from 5 to 9-year old, own-rooted vines growing at the Western Colorado Research Center - Rogers Mesa. Vines are planted at a vine x row spacing of 4-6' x 8', spur pruned on bilateral cordon, and trained either to a VSP or a high cordon. Buds were taken from shoots of moderate vigor that had no obvious sign of damage. Shoots were cut so as to leave a 4-bud spur, and eight buds were used from each shoot (i.e. bud position 5 to 12). Shoots were cut in the field into two-node sections. For each temperature treatment, twenty buds were selected at random and placed into a programmable freezer. The starting temperature for the freezing program was altered depending on the outside temperature at the time of bud collection. For example, on 31 October 2013 the outside temperature at the time of bud collection was ~36 °F, so the freezing program was initiated at a freezer temperature of 36 °F. In contrast, outside temperature on 12 December 2013 was 8 °F and the program was initiated at a freezer temperature of 8 °F. Irrespective of the starting temperature, the freezer was programmed to reduce the temperature by 5 °F over a 30-minute interval, and then hold at that temperature for 30 minutes. This cycle was repeated until the threshold temperature for a sample was reached. At the end of the holding period for that threshold temperature a twenty-bud sample was removed, temperature decreased by 5 °F over 30 minutes and held for 30 minutes, etc. After removal from the freezer, buds were left at room temperature for a minimum of 24 hours and then cut open to evaluate the tissue. Buds showing vibrant green tissue were judged to be viable (left photo below) whereas buds showing brown tissue were judged to be dead (right photo).



Photos: Sectioned grape buds showing the compound nature of the 'latent bud'. All buds are alive in the left photo while they are dead in the right photo (P – Primary bud; S – Secondary bud; T – Tertiary bud).

Cold hardiness is influenced by many different factors, including variety, crop load, harvest time, post-harvest conditions, vineyard weather conditions, and the duration of a cold event. With our freezing protocol buds are exposed to a certain minimum temperature for a period of 30 minutes. Shorter or longer periods at this minimum temperature may result in lower or higher bud damage. For example,

Table 1 shows that the percentage of dead primary buds for the varieties Chardonnay and Syrah increases as exposure time to -10 °F is extended from 30 to 90 and 180 minutes.

Table 1: Effect of the duration of a cold event (at -10 °F) on percentage of dead **primary** buds[1]

		Time at -10 °F (min)		
Variety	**Date**	**30**	**90**	**180**
Chardonnay	5 Dec 2006	10	30	35
Syrah	5 Dec 2006	5	77	100

[1] Note that the percentage damage is for the primary bud only. The damage is somewhat less when secondary and tertiary buds are included as they are more cold-hardy than the primary bud.

There is a genetically determined limit to cold hardiness (e.g. in mid-winter Concord is more cold-hardy than Riesling, which is more cold-hardy than Chardonnay). However, while this is true for mid-winter hardiness, the ranking might be different at the start or end of the dormant season. Some varieties will acclimate earlier in fall and will be able to withstand colder temperatures earlier in the dormant season than varieties that have otherwise more mid-winter hardiness. Likewise, early bud-breaking varieties tend to loose their hardiness earlier in spring and might be damaged at warmer temperatures than late-breaking varieties, irrespective of their mid-winter hardiness. Also, cultural practices can have a profound influence if the genetic potential of a particular variety is achieved.

In very general terms, warm temperatures tend to reduce bud hardiness while cold temperatures tend to induce more hardiness (within limits). Hence, the weather conditions at a site will influence the ability of buds to withstand cold temperature, and the values presented in Table 1 are in part affected by the temperature conditions at our research vineyard (Fig. 1). Values from other sites might differ depending on local conditions, and values for varieties grown at our research vineyard at the Western Colorado Research Center - Orchard Mesa near Grand Junction, Colorado can be found at:
http://aes-wcrc.agsci.colostate.edu/cold-hardiness-and-bud-evaluation/

The data presented here is for information only, and growers should make their own assessment. Information on how to determine bud injury can also be found at the above-mentioned web address.

Cold hardiness information for a large number of varieties grown in Washington State, a region with a semi-arid climate with some similarity to the climate of Colorado, can be found at WSU's viticulture page:
http://wine.wsu.edu/research-extension/weather/cold-hardiness/

Table 2: Percentage of dead **primary** buds as affected by temperature[1]. Most recent updates highlighted in red.

Variety	**Date**	**Control[2]**	**15ºF**	**10ºF**	**5ºF**	**0ºF**	**-5ºF**	**-10ºF**	**-15ºF**	**-20ºF**
Aromella	30 Oct 2013	0			0	5	90			
Aromella	13 Nov 2013	0			0	0	0	20		
Aromella	26 Nov 2013	0				0	0		50	
Aromella	12 Dec 2013							15	24	20
Aromella	8 Jan 2014	5						0	0	85
Aromella	23 Jan 2014	3						0	6	34

Variety	Date	Control[2]	15ºF	10ºF	5ºF	0ºF	-5ºF	-10ºF	-15ºF	-20ºF
Aromella	5 Feb 2014	0						5	5	5
Aromella	26 Feb 2014	0				0	0	5	90	
Aromella	19 Mar 2014	0				0	20	100	100	
Aromella	2 Apr 2014	0	5	10	0	55				
Chambourcin	30 Oct 2013	0		0	0	15	100			
Chambourcin	26 Nov 2013	0				0	5		90	
Chambourcin	8 Jan 2014	13					5	0	30	80
Chambourcin	5 Feb 2014	30						40	50	90
Chambourcin	19 Mar 2014	35			35	45	25	73		
Rkatsiteli	13 Nov 2013	0			0	0	0	100		
Rkatsiteli	12 Dec 2013	25					23	45	26	63
Rkatsiteli	23 Jan 2014	24					25	13	94	100
Rkatsiteli	26 Feb 2014	15				20	35	85	100	
Rkatsiteli	2 Apr 2014	25	15	10	5	50				

[1] Note that the percentage damage is for the primary bud only. The damage is somewhat less when secondary and tertiary buds are included as they are more cold-hardy than the primary bud.
[2] "Control" values are from samples not placed inside the freezer.

Last update: 4 Apr 2014

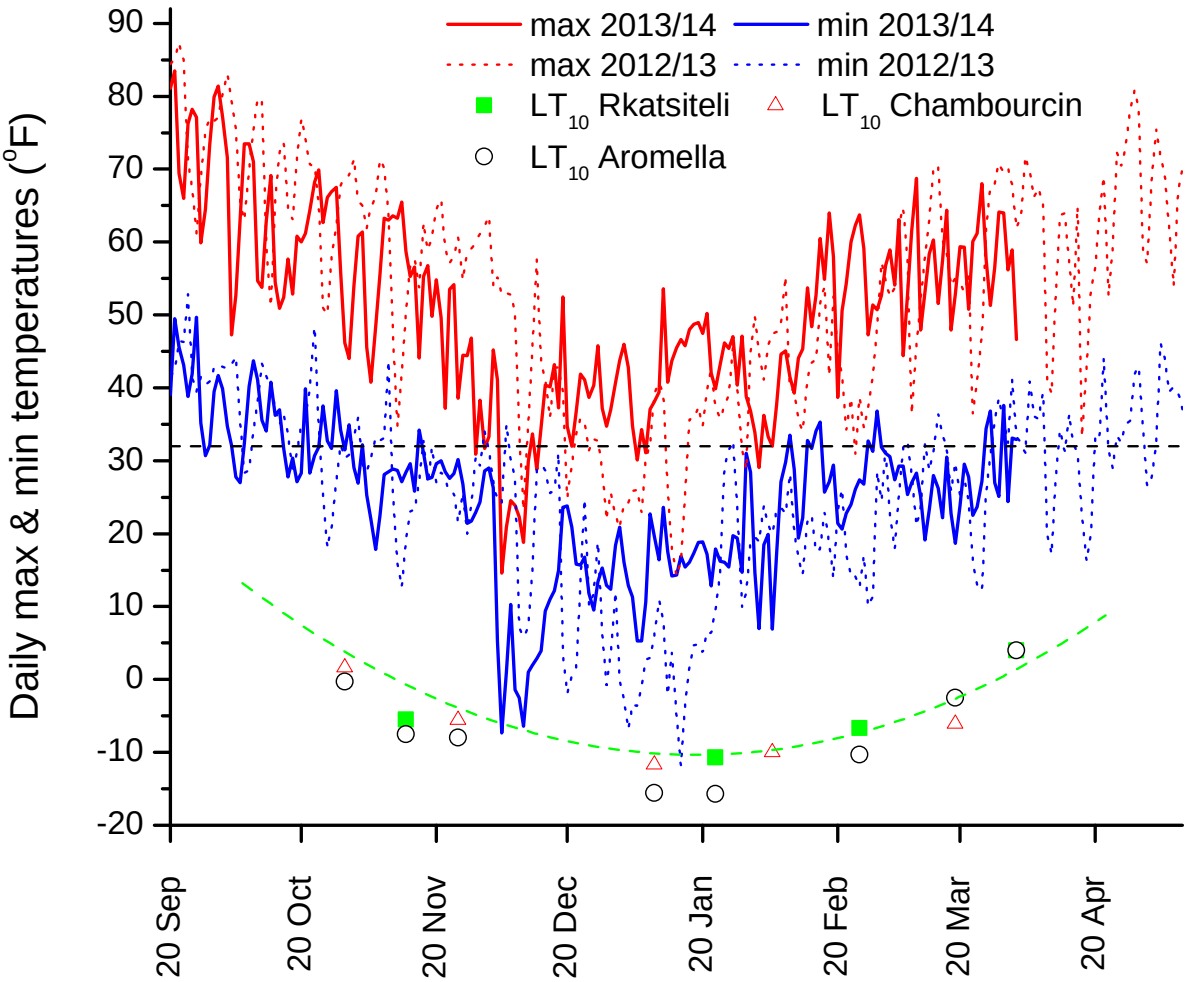


Fig. 1: Daily maximum and minimum temperatures recorded at the Western Colorado Research Center – Rogers Mesa near Hotchkiss, Colorado for 2012/13 & 2013/14, and critical temperatures for a 10 % bud kill (LT_{10}) estimated from Table 2. The dashed line represents a predicted value for LT_{10} for Rkatsiteli based on a curve fitted to previous years' data. Temperature data for various locations within the Grand Valley can be found at http://www.winecolorado.org/colorado-grape-growing/weather-station-network/. Meteorological data from other locations throughout Colorado may also be available from the COlorado AGricultural Meteorological nETwork - COAGMET.