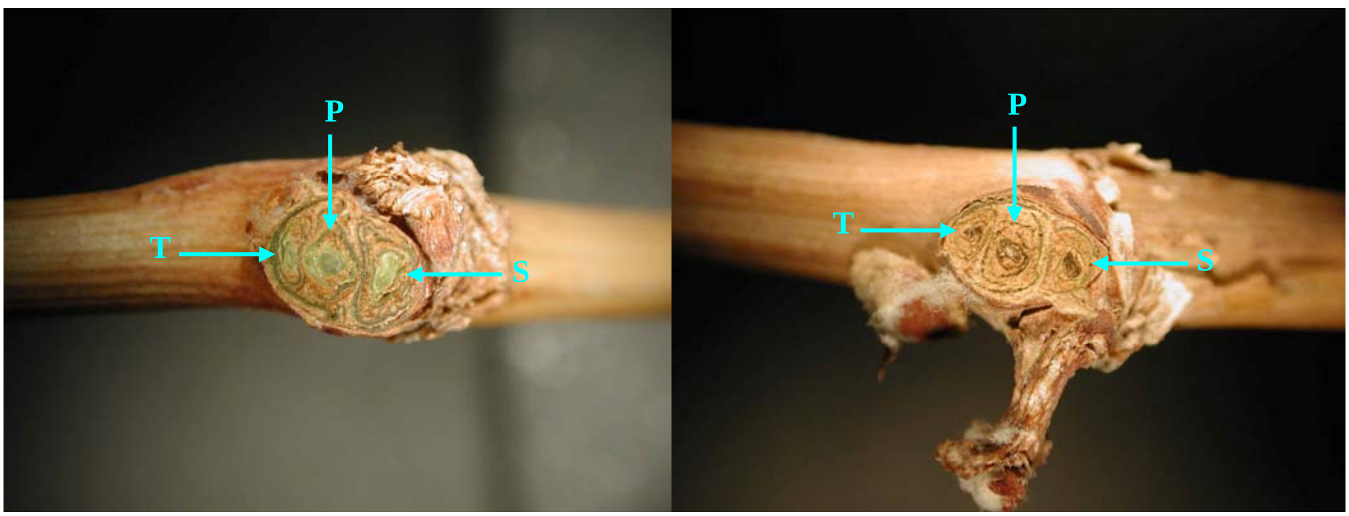
Cold hardiness of grapevine buds at the Western Colorado Research Center - Orchard Mesa near Grand Junction, Colorado, 2011/12.

Horst Caspari & Amy Montano, Colorado State University, Western Colorado Research Center, 3168 B ½ Road, Grand Junction, CO 81503

Dormant buds were collected from 10 to 20-year old, own-rooted vines growing at the Western Colorado Research Center - Orchard Mesa. Vines are planted at a vine x row spacing of 5’ x 9’ or 5' x 10', spur pruned on bilateral cordon, and trained to a VSP. 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 nodes were selected at random, placed in plastic bags, and then placed into a programmable freezer. The starting temperature for the freezing program was set to equal the outside temperature at the time of sampling. For example, on 19 October 2011 the outside temperature at the time of bud collection was ~45 °F, so the freezing program was initiated at a freezer temperature of 45 °F. In contrast, outside temperature on 7 December 2011 was ~15 °F and the program was initiated at a freezer temperature of 15 °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 one bag containing twenty buds 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. Concord is more hardy than Riesling, which is more 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 Rogers Mesa Research Center near Hotchkiss, Colorado can be found at:
http://www.colostate.edu/programs/wcrc/pubs/viticulture/viticoldhardy.htm

The data presented here is for information only, and growers should make their own assessment. Information on how to determine bud injury can be found at:
http://www.colostate.edu/programs/wcrc/pubs/viticulture/EvaluatingBudDamage.pdf

Cold hardiness information for a large number of varieties grown in Washington State, a region with a similar climate to that 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]	**25ºF**	**20ºF**	**15ºF**	**10ºF**	**5ºF**	**0ºF**	**-5ºF**	**-10ºF**	**-15ºF**
Chardonnay	19 Oct 11	0	5	5	15						
Chardonnay	4 Nov 11	0			5	0	35				
Chardonnay	9 Nov 11	0				0	5	30			
Chardonnay	17 Nov 11	0					0	10	85	100	
Chardonnay	23 Nov 11	0						5	35	100	
Chardonnay	1 Dec 11	0					0	5	35	100	
Chardonnay	7 Dec 11	0						0	10	70	95
Chardonnay	15 Dec 11	0						15	35	95	100
Chardonnay	23 Dec 11	0						10	0	90	100
Chardonnay	29 Dec 11	0						0	25	50	100
Chardonnay	5 Jan 12	0						0	15	90	100
Chardonnay	12 Jan 12	0						5	10	85	100

Variety	Date	Control[2]	25ºF	20ºF	15ºF	10ºF	5ºF	0ºF	-5ºF	-10ºF	-15ºF
Chardonnay	25 Jan 12	0						0	5	85	100
Chardonnay	3 Feb 12	2						0	20		100
Chardonnay	15 Feb 12	0						10	10	100	100
Chardonnay	24 Feb 12	0					0	0	10	75	
Syrah	19 Oct 11	0	0	0	25						
Syrah	4 Nov 11	0			5	15	100				
Syrah	9 Nov 11	0				0	0	70			
Syrah	17 Nov 11	0					0	0	70	100	
Syrah	23 Nov 11	0						45	90	100	
Syrah	1 Dec 11	0					0	0	10	100	
Syrah	7 Dec 11	0						0	10	80	100
Syrah	15 Dec 11	0						0	10	100	100
Syrah	23 Dec 11	0						0	0	65	100
Syrah	29 Dec 11	0						0	5	55	100
Syrah	5 Jan 12	6						0	10	40	100
Syrah	12 Jan 12	0						0	5	55	100
Syrah	25 Jan 12	0						5	5	40	100
Syrah	3 Feb 12	0						0	0		85
Syrah	15 Feb 12	0						0	0	65	90
Syrah	24 Feb 12	0					10	10	10	35	

[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: 27 Feb 2012

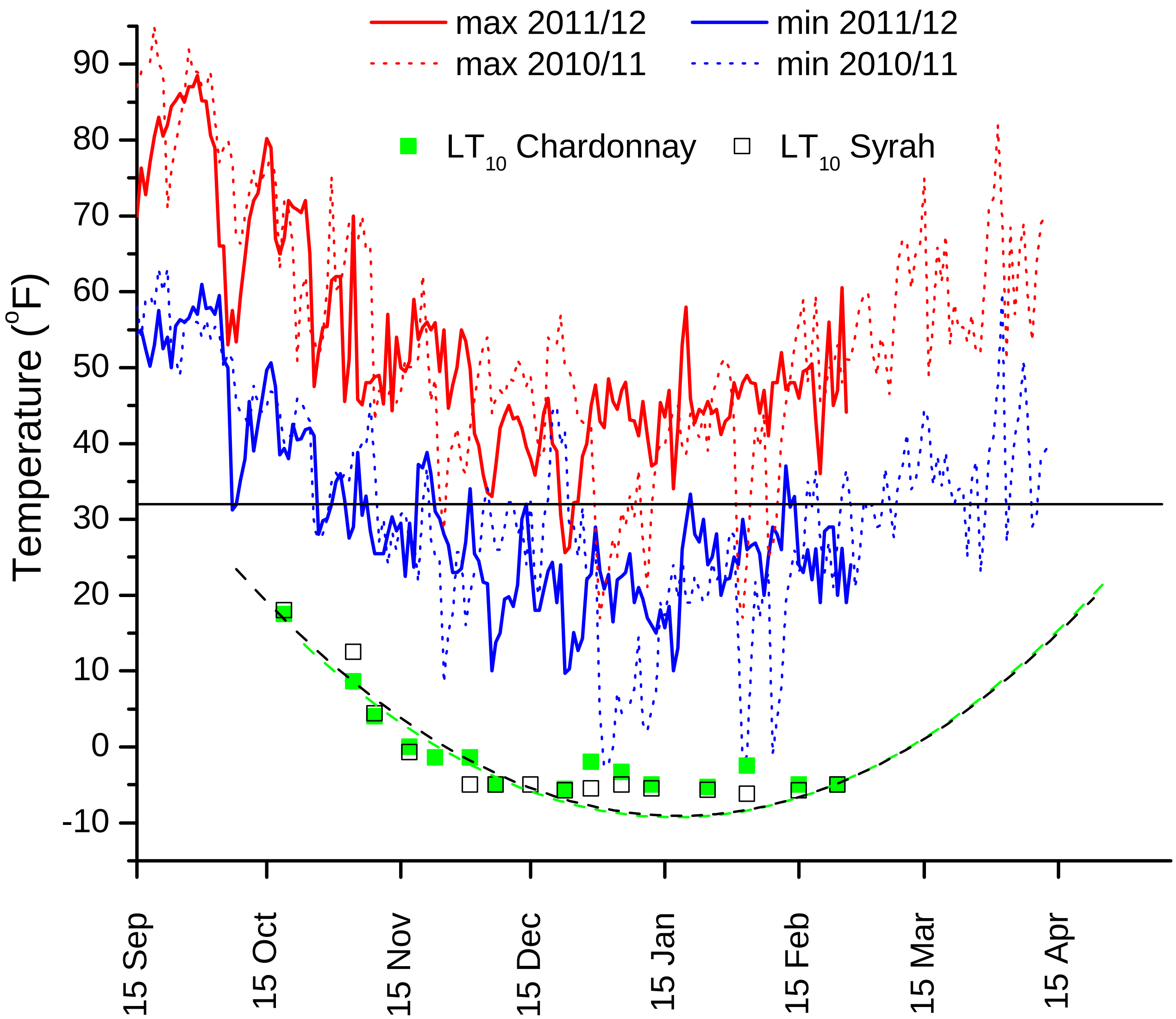


Fig. 1: Daily maximum and minimum temperatures recorded at the Western Colorado Research Center - Orchard Mesa near Grand Junction, Colorado, 2010/11 & 2011/12, and critical temperatures for a 10 % bud kill (LT_{10}) estimated from Table 2. The dashed lines represent predicted values for LT_{10} based on curves fitted to previous years' data. Temperature data for various locations within the Grand Valley can be found at www.caveonline.org/weatherstations/cave-weather-station-network. Meteorological data from other locations throughout Colorado may also be available from the COlorado AGricultural Meteorological nETwork - COAGMET.