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Comparison of 'Cabernet Sauvignon' and 'Cabernet franc' Grapevine Dormant Bud Cold Hardiness

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Abstract

Cold hardiness of 'Cabernet Sauvignon' (CS) and 'Cabernet franc' (CF) dormant buds was compared during two winters by thermal analysis of bud freezing events. The vines were of the same age and planted in adjacent blocks of a northern Virginia vineyard. CF buds were typically one to two degrees (C) hardier than CS buds except in spring, when CF buds deacclimated more rapidly than CS buds. The general pattern of superior cold hardiness of CF buds is consistent with limited grower experience with whole-vine responses of these two *Vitis vinifera* cultivars to low temperature stress in the field.

of the cultivars currently being evaluated in Virginia are common to warm or hot climates that lack winters severe enough to cause significant cold injury. Thus, information on the cold hardiness of those cultivars is lacking. Controlled freezing methods expedite cold hardiness evaluations of novel plant material. For grapevines, the use of differential thermal analysis and thermal analysis of dormant buds (1, 6, 9) provides a quick, convenient measure of bud cold hardiness. Bud cold hardiness does not represent whole-vine cold hardiness. However, bud cold hardiness does tend to parallel cane tissue hardiness (10) and thus offers a rapid, predictive measure of relative differences in whole-vine cold hardiness.

This study was conducted to determine the relative cold hardiness of 'Cabernet Sauvignon' and 'Cabernet franc' dormant buds. Both of these red Bordeaux cultivars are fairly well adapted to the mid-Atlantic growing season and produce good to excellent wines. However, much more is known of the cold hardiness of 'Cabernet Sauvignon,' which is considered "not hardy" (7) or "tender" (3) in northern U.S. Limited grower experience suggested that 'Cabernet franc' possessed superior cold hardiness. If so, 'Cabernet franc' might be recommended for those growers who wish to plant a red *V. vinifera* cultivar in regions marginally suitable for 'Cabernet Sauvignon.'

Methods and Materials

Dormant buds of 'Cabernet Sauvignon' (CS) and 'Cabernet franc' (CF) were evaluated for cold hardiness at regular intervals during the 1986-1987 and 1989-1990 dormant periods. The vines used in this study had been planted in adjacent blocks of a northern Virginia vineyard in 1985. Sampling of both cultivars was confined to a contiguous area of *ca.* 50-m radius. The rootstock cultivar 'C-3309' was used with both cultivars. Cultural practices were comparable between the two culitvars and included permanently sodded row centers, a vine spacing of 2.7 m by 1.8 m (row x vine), bi-lateral cordon training (cordon at 1.1 m above ground), and effective pest management. Both cultivars were cropped at less than two kg of fruit per vine in 1989. Wood maturation was excellent in both years with both cultivars and neither sustained appreciable cold injury from field exposure in either year. A thermograph was located and monitored at the site during the 1989-1990 winter.

Bud sampling consisted of collecting one cane per vine from five or six vines, selected at random in each cultivar planting. Sampled canes were of a moderate diameter and bore uniformly well matured periderm. The sampling of CF vines purposely avoided previously flagged vines that were apparently affected by leafroll virus. Buds at nodes three through 12 were use for cold hardiness determinations.

Bud cold hardiness was determined by thermal analysis of bud freezing events under controlled freezing conditions in the lab. The freezing equipment and techniques were essentially the same as those described by Wolf and Pool (8). Buds and about two mm of subtending node tissue were excised from canes and mounted on one side of thermoelectric modules (five buds per module). Water-moistened filter paper was used with the modules to prevent substantial supercooling of node tissues (9). Buds were cooled at three to four degrees per hour from a starting temperature of 0° to 3° C. Module voltage data and separate thermocouple temperature data were recorded and later plotted to determine the temperature of freezing events in buds (Fig. 1). A median low temperature exotherm (LTE) was determined

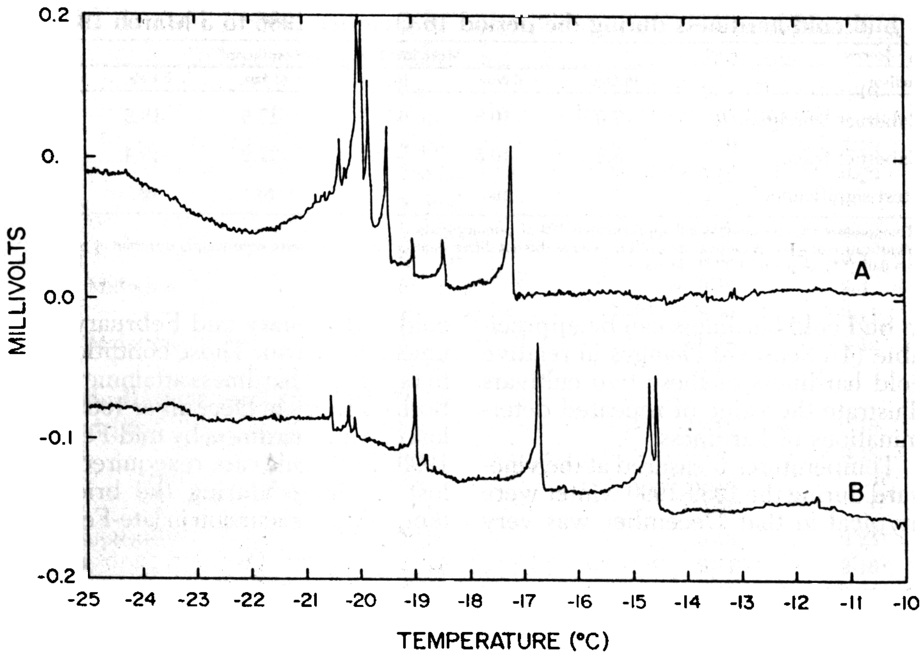

Figure 1. Representative freezing patterns of 'Cabernet franc' (A) and 'Cabernet Sauvignon' (B) buds on 24 January 1990. Each plot consists of five buds; however, only four exotherms were judged (on basis of size) to result from freezing primary buds in B. Median LTEs were -19.6°C (A) and -15.7°C (B).

for each module based on the apparent primary bud LTEs (9). The median LTEs were averaged by cultivar to derive a single mean LTE for that particular sample date. The mean LTE was comparable to an LT_{50} value used in dose/response evaluations of plant cold hardiness. Median LTEs, at each sample date, were subjected to a t-test (SAS-PC, SAS Institute, Cary, NC 27511) to determine if the two cultivars differed significantly in bud cold hardiness.

Results and Discussion

CF buds tended to be more cold hardy than CS buds during the 1986-1987 dormant period; however, differences in hardiness were only significantly different at three test dates (Table 1). Differences in CF and CS bud cold hardiness were more consistent during the 1989-1990 winter (Fig. 2) where, again, the trend was one of CF buds being superior in cold hardiness to CS buds. The exception to that trend occurred in March 1990, as CF buds lost cold hardiness more rapidly than CS buds. That observation was consistent with the established pattern of budbreak with these two cultivars: CF budbreak is mid-season, whereas CS is very late (2). The inconsistencies in relative cold hardiness could relate to real, but temporal, changes in cold hardiness and/or to variability introduced with sampling. Although we attempted to select only "exterior" (with respect to canopy location) canes that had likely been exposed to light during development, it is recognized that within-vine variation

Table 1. Comparison of 'Cabernet Sauvignon' and 'Cabernet franc' primary bud cold hardiness during the period 16 October 1986 to 5 March 1987.

Cultivar	Mean low temperature exotherm[y]					
	16 Oct.	6 Nov.	10 Dec.	13 Jan.	5 Feb.	5 Mar.
Cabernet Sauvignon	-7.0	-10.8	-15.5	-17.5	-18.3	-15.6
Cabernet franc	-8.2	-10.5	-17.4	-17.9	-19.4	-18.8
t-test significance[z]	*	ns	**	ns	ns	***

[y]Temperature (°C) required to kill approximately 50% of primary buds.
[z]Significance of t-test of cultivar mean LTEs: means did not differ significantly (ns) or were significantly different at p = 0.05 (*); p = 0.01 (**); or p = 0.001 (***) levels.

in bud cold hardiness can be appreciable (4). Seasonal changes in relative cold hardiness of these two cultivars illustrate the value of repeated determinations of hardiness.

Temperatures measured at the vineyard during the 1989-1990 winter were atypical in that December was very cold and January and February were unusually warm. Those conditions led to rapid cold hardiness attainment with both cultivars in December 1989 and a loss of some hardiness by mid-February 1990. Both cultivars reacquired some lost hardiness during the brief low temperature excursion in late-February

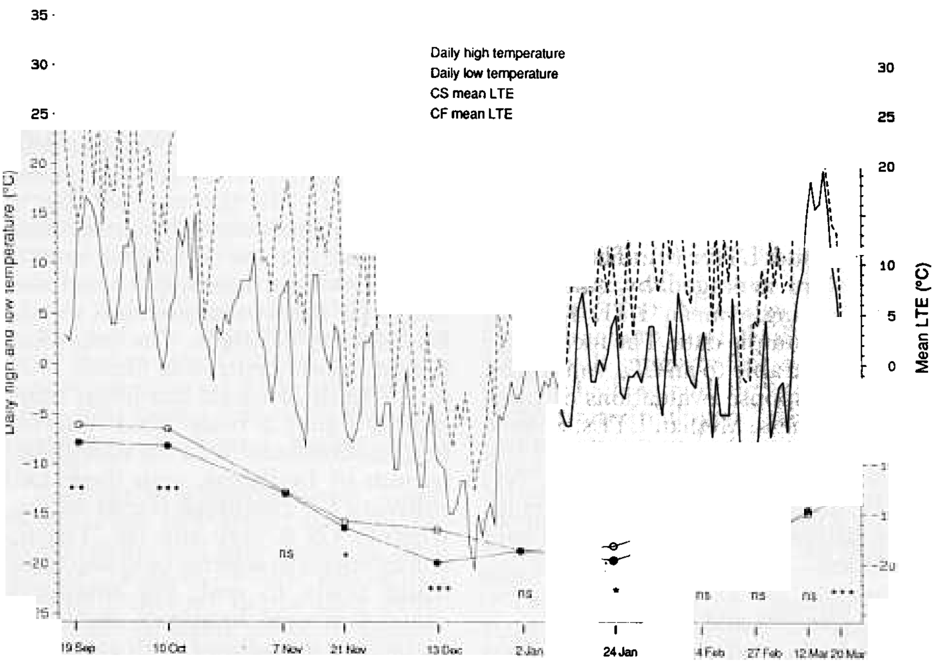

Figure 2. Daily high and low air temperature and mean low temperature exotherm (LTE) data for 'Cabernet Sauvignon' (CS) and 'Cabernet franc' (CF) buds during the period from mid-September 1989 through late-March 1990. Characters subtending each cold hardiness evaluation date refer to the significance of a t-test of cultivar mean LTEs: means did not differ significantly (ns) or were significantly different at p = 0.05 (*); p = 0.01 (**); or p = 0.001 (***).

and neither sustained greater than five percent bud injury. On the basis of unpublished work by the authors and collaborators in New York and Washington States, both cultivars could be expected to develop greater cold hardiness in regions or seasons having sustained lower, but nonlethal, temperatures.

The lowest temperature recorded at the vineyard during the 1989-1990 winter was -20°C on 22 December 1989. That temperature was several degrees cooler than the mean LTE determined with CS buds on 13 December 1989. However, less than five percent primary bud injury was observed with either cultivar in a bud viability assay on 2 January 1990. The lack of greater injury indicated that buds had presumably increased cold hardiness between 13 and 22 December. In an independent study of the same CF vines, bud hardiness had increased one degree between 13 and 20 December (data not shown).

The differences in cold hardiness between CS and CF buds were not great, but it is not uncommon to have differences of one or two degrees (C) meaning the difference between a full crop and a substantial crop reduction. Thus, the generally consistent hardiness superiority of CF buds should ensure more consistent production than CS at sites prone to winter cold injury. Differences in bud cold hardiness reported here do not infer that the cold hardiness of canes and trunks differed to the same extent; however, the correspondence between bud and cane cold hardiness is close enough (10) that buds are a reliable indicator of relative cold hardiness. Limited whole-vine observations of CS and CF in other Virginia vineyards substantiates the relative differences found here.

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I certify that the statements made by me above are correct and complete. R. M. Crassweller, Business Manager. September 7, 1990.