Mechanics for Avoiding Injury to Cold-Tender Grape Varieties

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In many situations winter low temperatures can be the most limiting factor to the successful production of grapes in cool climate viticultural regions. The soils, the length of growing season, the heat accumulation during the growing season and the management skill of the grower may all be quite adequate for the successful production of quality grapes. Nevertheless, all those factors are for naught if the vines cannot survive through the winter. We know that vines acclimate, that is, they become more tolerant of low winter temperatures as they go into dormancy in the late fall. They deacclimate, that is, they become less tolerant of low temperatures as air temperatures increase. During the winter there can be shifts in the acclimation of grapevine tissues. Episodes of warming spells followed by rapid drops in temperature can be disastrous for grapevine tissue survival. Even under the best conditions for the acclimation of grapevine tissues, there are genetic limitations to their tolerance to low temperature, which vary from variety to variety. Hence the categorizing of hardy versus cold-tender varieties. We know that the ability of grapevine tissues to withstand low temperatures is primarily a matter of the intensity of this stress. It is primarily a matter of the temperature experienced by these tissues rather than the duration of a low temperature stress.

From the vantage point of a plant stress physiologist, there are two ways of dealing with low temperature stresses to grapevine tissues. One is through tolerance by managing grapevine tissues so they become more acclimated to survive low temperatures. The other strategy is avoidance by managing grapevine tissues so they don't come in contact with low temperatures. We have conducted several experiments in Michigan vineyards over many years to develop strategies of low temperature avoidance in grapevine tissues.

In one study we documented the benefits of snow cover as an insulator to grapevine tissues. By recording hourly temperatures at 2-inch height intervals we found at times dramatic differences of as much as 27 ^{o}F in temperatures 2 inches above (-13^{o}F) and below (14 ^{o}F) the snow surface. Therefore, whenever snow cover occurs, it can be a tremendous tool for low temperature avoidance on grapevine tissues. Another outcome of this study was the realization that the snow surface functions like that of the ground surface during a radiation freeze with the very coldest temperatures taking place right at the snow line. Therefore, the snow surface can actually be detrimental to the survival of grapevine tissues. We also concluded that even in an area renowned for its snow cover, such as the Traverse City, Michigan, snow is not a totally reliable method for protecting grapevine tissues. There can be more periods without snow cover than one might imagine. Nevertheless, a relatively low cost approach for partial protection against low winter temperatures is to place portions of the grapevine at the ground level to take advantage of snow cover whenever it occurs.

Our other efforts to achieve low temperature avoidance for grapevines during the winter involved two insulating materials, soil and straw. Both of these materials have excellent insulating properties. In a five-year study involving Merlot grapevines (Zabadal, 2003) winter-minimum temperatures under soil and straw cover averaged 29^{o}F and 15^{o}F degrees warmer than the ambient air temperature at 5 feet above ground level, respectively (Table 1). During that study these insulating materials protected not only graft unions but also fruiting canes, which had been placed near the ground. It was possible to preserve a fruiting potential of at least 3 tons per acre in every year of the study including two years with -17^{o}F and -18^{o}F winter minimum temperatures.

Table 1. Winter minimum temperatures experienced at four locations within a Merlot vineyard near Baroda, MI for five winter periods. Temperature in degrees Fahrenheit.

	Winter period					
Location	**1994-95**	**1995-96**	**1996-97**	**1997-98**	**1998-99**	**5-year ave**
150 cm above ground	3	-17	-8	5	-18	-7
30 cm above ground	3	-13	-6	5	-9	-4
Under straw[1]	12	1	9	10	3	7
Under soil[2]	21	21	23	19	19	21

[1] Under straw mulch and 20 cm above the ground surface
[2] Approximately 10 cm below the surface of mounded soil

Encouraged by those results, we set out to develop techniques that could utilize soil or straw for this purpose on a commercial scale. For the use of soil, we developed two pieces of equipment, one to hill up and the other to remove mounds of soil around the grapevine. The hilling-up device that we ultimately chose was a three disc plow. This plow is designed so the first plow feeds a second plow, which feeds the third, which then makes the ridge of soil under the trellis. The strategy is to gather soil in a relatively wide swath (20 to 24 inches) and shallow (3 to 4 inches) depth to minimize root pruning as well as soil erosion potential. This unit has worked well for several years. Where there is a permanent sod in the vineyard row middles, the sod must first be broken up through rotovation for this plow to work. Rotovation is also necessary on very heavy soils. In our experience with light-to-moderate soils, after an initial year of performing that rotovation, it is no longer necessary to do so. The take-out equipment we developed is a modification of a weed badger cultivation unit. We made two major modifications of this unit. One was to dedicate all of the hydraulic capacity of this unit to the rotation of the take-out head. The external hydraulic capacity from the tractor was then used for all of the up-and-down and in-and-out movements of the unit. In this way there is a constant, uninterrupted rotation of the takeout head through the relatively large volume of soil that is being moved. The second modification was the construction of two custom implements for the take-out head. We have called the first of these a paddle wheel, which is a rotating set of metal plates that undercut the soil mound and remove the majority of the soil. After this procedure there is a so-called Aisland@ of soil remaining around the grapevines and trellis posts. That soil is removed by a second process of brushing. With both operations the intent is to undercut the soil volume below the placement of the graft union. Details for construction of the take-out unit can be found at our website under SWMREC reports at: http://www.msue.msu.edu/swmrec .We have attempted to create a partial budget for the cost of this equipment and its use (Table 2). Given the assumptions that we made, we estimate the annual cost of performing these functions at $128 per acre. It would certainly be possible for other assumptions to be made to this partial budget which would change this dollar figure dramatically.

Table 2. A partial budget for hilling-up/take-out procedures.

Equipment	
Hiller and Takeout $10,000/(20 acres x 10 yrs)	= $ 50/acre/yr
Tractor (2.8 hrs x $15/hr)	= $ 42
Labor	
Hilling up (0.8 hrs x $12.00)	= $ 10
Takeout (2.0 hrs x $12.00)	= $ 24
Set up and maintenance (3.0 hrs x $12.00)/20 acres	= $ 2
Total	**= $128 / acre**

The use of straw (or waste hay will work just as well) was achieved with a Patz mulching unit. In our trials we had used two rates of straw and found little difference in the insulating value between the use of 3 and 6 tons of straw mulch per acre. The 3-ton per acre rate translates to about 125 small bales of straw per acre. The straw mulching procedure involves a lower initial capitalization cost for equipment and a much greater cost for materials and labor to execute the process (Table 3). Our assumptions relating to the partial budget for this procedure are greatly influenced by the cost of the straw mulch material.

Admittedly, in most situations the economic worth of this procedure will depend upon obtaining a supply of straw at relatively low cost. In my own personal instance this translates to growing a rye cover crop on some low land acreage and having it custom baled.

Table 3. A partial budget for straw mulch procedures

Equipment	
Mulching equipment ($3600)/(20 acres x 10 yrs)	= $ 18
Tractor (7 hrs x $10/hr)	= $ 70
Labor	
Apply straw (7 hrs x 2 persons x $9.00/hr)	= $ 126
Remove straw (4 hrs x $9.00/hr)	= $ 36
Materials	
Straw (125 bales/acre x $2.50/bale)	= $ 313
Maintain equipment (2 hrs x $9.00)/20 acres	= $ 1
Total	**$ 564**
Without any cost for straw	**$ 251**

We have tried several ways to place fruiting canes near the ground in late fall so they might be protected by snow, soil or straw cover. These include temporarily moving a trellis wire to the ground and loosely attaching canes to it using landscape staples to hold down canes. Our current effort with the straw-mulching procedure utilizes a heavy-grade of plastic baling twine, which is run through a staple at the base of each trellis post. In the fall we prune 2 canes per vine and wrap them lightly around this twine. In the spring we take hold of this twine and pull upward to remove the canes from the straw. We anticipate using this plastic twine for several years and leaving it in place. To use this strategy one must create a reservoir of canes relatively close to the ground near the graft union. We leave 1 to 3 renewal spurs in the vicinity of the graft union even in years when we are not looking to replace trunks. After the canes have been removed from the soil or straw we tie them up to the trellis if we need to use them for fruiting or we remove them from the vine in years when this cropping insurance is not necessary. We can then proceed to remove the soil mound as described. In the case of straw, we simply move the straw away from the base of each vine and leave the straw in place to assist in weed control and soil moisture retention.

Certainly these procedures are warranted only for high value crops. Nevertheless, they do provide reliability for fruiting relatively cold-tender varieties. A modification for these procedures is likely to occur in the years ahead. A frequently asked question regarding the use of straw or hay mulch around grapevines is the hazard of rodent damage to grapevines. Although this is a possibility and is experienced on occasion, it is unusual for rodents to feed on grapevine tissues and it has not been a problem more than 95 percent of the time.

Reference:

Zabadal, T.J. The Maintenance of Fruiting Potential Through the Winter for >Merlot= Grapevines Grown in Southwestern Michigan. 2003. Small Fruits Review 2(4):37-44.