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Freezing Tolerance in Frontenac and Seyval blanc Grapevines

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Abstract
Grape cultivars that are grown in cold climates must be able to tolerate low winter temperatures that typically occur in a given region. Cold hardiness of grapevines is based on primary bud survival, however, many interspecific cultivars can produce a crop on secondary buds if primary buds are injured. Moreover, cane tissues, which are necessary for secondary crop production, can be as susceptible to freezing injury as secondary buds. There is relatively little information concerning the freezing tolerance of cane tissues during the overwintering period, although high freezing tolerance of cane tissues is important where severe freezing events can be anticipated. The objective of this investigation was to characterize differences in freezing tolerance of bark and xylem cane tissues of a very hardy (Frontenac) and a moderately hardy (Seyval blanc) grape cultivar during autumnal acclimation, midwinter period, and vernal deacclimation. A second objective was to identify biochemical markers associated with increased freezing tolerance of grapevine canes (not included in this report).

Keywords
RFR A9004, Horticulture

Disciplines
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Freezing Tolerance in Frontenac and Seyval blanc Grapevines

RFR-A9004

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Introduction

Grape cultivars that are grown in cold climates must be able to tolerate low winter temperatures that typically occur in a given region. Cold hardiness of grapevines is based on primary bud survival, however, many interspecific cultivars can produce a crop on secondary buds if primary buds are injured. Moreover, cane tissues, which are necessary for secondary crop production, can be as susceptible to freezing injury as secondary buds. There is relatively little information concerning the freezing tolerance of cane tissues during the overwintering period, although high freezing tolerance of cane tissues is important where severe freezing events can be anticipated. The objective of this investigation was to characterize differences in freezing tolerance of bark and xylem cane tissues of a very hardy (Frontenac) and a moderately hardy (Seyval blanc) grape cultivar during autumnal acclimation, midwinter period, and vernal deacclimation. A second objective was to identify biochemical markers associated with increased freezing tolerance of grapevine canes (*not included in this report).*

Materials and Methods

Seyval blanc and Frontenac grapevines established in a vineyard at the Iowa State University Horticulture Research Station (HRS), Ames, IA, in Spring 2002 were sampled randomly between August 20, 2008 and April 22, 2009. Percentage of periderm development was measured on excised canes by measuring the length of progression from the base outward during the early stages of cold acclimation.

Ten to 12 basal, 12-in. sections of canes from Frontenac and Seyval blanc plants were collected at 15 dates as determined by 5°C (9°F) changes in temperature and divided into one-inch internodal segments. Segments were subjected to controlled laboratory freezing tests. For each sampling date, four replicate segments were exposed to a treatment temperature in a sequence of descending temperatures. After each test, samples were allowed to thaw, incubated for three days and percentage of injury was evaluated by visual estimation with increments at 0, 25, 50, 75, and 100% injury for bark and xylem tissues. Bark included all tissues including and outside of the vascular cambium. Averaged injury percentage values were fit to a Gompertz function to calculate the temperatures that caused 50% tissue injury (LT_{50}).

Results and Discussion

Accumulation of periderm occurs in the autumn as grapevines enter dormancy and begin to acclimate to lower temperatures and may indicate a vine's dormancy or cold-hardiness status. However, periderm on Seyval blanc canes developed earlier than on Frontenac canes (Figure 1).

Frontenac is rated as very cold hardy, but cane tissues acclimated at a similar rate as those from Seyval blanc plants until November 11, 2008 rather than reaching a greater degree of acclimation earlier (Figure 2). However, Frontenac was more responsive to decreasing temperature than Seyval blanc as the acclimation period progressed with 15°C (27.9°F) greater maximum freezing tolerance during the midwinter period (Figure 2).

Grapevine bark is typically less freezing tolerant than xylem, yet bark tissues from Frontenac plants gained as much as 7.8°C (14.4°F) greater freezing tolerance than xylem tissues during late acclimation and midwinter (Figure 2). Freezing tolerance of bark tissues from Seyval blanc canes was similar to xylem tissues during the same time period but did not exceed xylem freezing tolerance to the same extent or duration as observed in Frontenac (Figure 2). Greater freezing tolerance of bark than xylem in grape canes may assist the overall freezing tolerance of the vine.

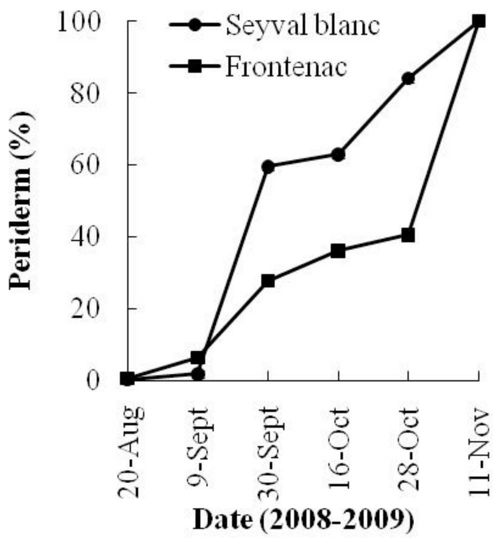

Figure 1. Percentage of length of periderm development with standard error from canes excised between August 20 and November 11, 2008.

Seyval blanc may have difficulty at sites prone to exceeding expected regional low temperatures, however, a greater reacclimation capacity was observed compared with Frontenac tissues after an April 9 freezing event (Figure 2). Seyval blanc bark and xylem LT_{50} values increased 9.0 and 2.0% more than Frontenac bark and xylem, respectively. A greater reacclimation capacity may lend suitability to sites accustomed to temperature fluctuation or late freezing events in the spring if minimum low winter temperature thresholds are not exceeded. Reacclimation capacity of Frontenac was less than Seyval blanc (Figure 2), yet a more gradual deacclimation rate was observed and a greater degree of freezing tolerance was retained during deacclimation in Frontenac cane tissues.

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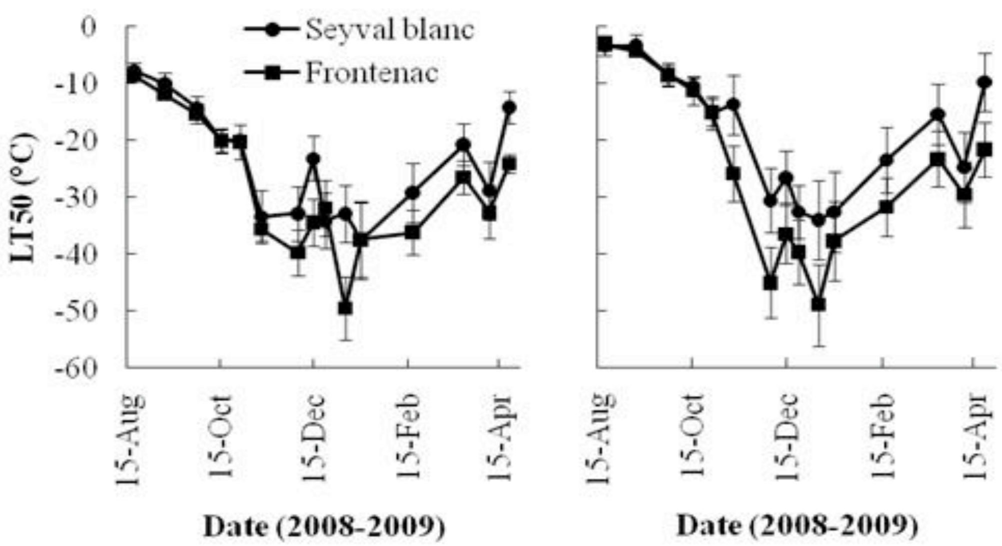

Figure 2. LT_{50} values with standard error for Frontenac and Seyval blanc xylem (left) and bark (right) cane tissues sampled between August 2008 and April 2009.