Freeze-thaw temperature oscillations promote increased differential gene expression during grapevine bud dormancy

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Abstract

In northern cold climate conditions, chilling requirement fulfillment in dormant grapevine buds is slowed or stopped by subzero temperatures impacting the transcriptional processes needed to complete chilling requirement. Cabernet Franc and Reisling in Geneva, NY were used to determine the impact of natural oscillating temperatures on grapevine bud transcriptional activity during light and dark periods of a two-week period in January with fluctuating diurnal winter temperatures. Cabernet Franc and Reisling bud samples were collected at 32 time points during the natural vineyard temperature cycle at 6:00 (dark), 14:00 (light) and 18:00 (dark) hours) to monitor gene expression in consecutive freezing and non-freezing temperature oscillations. Genotype, light and dark, and temperature oscillations conditions were explored. Four distinct conditions were analyzed 1) genotype difference with constant light/dark temperature conditions; 2) light vs dark with similar temperature conditions; 3) buds in light (14:00) at >0C vs <0C; 4) buds in dark (6:00 or 18:00) at >0C vs <0C; 4). Principal components analysis indicated that genotype accounted for 66% of variance and there were 1,916 and 1,559 differentially expressed genes (DEG) up and down regulated respectively, in Reisling relative to Cabernet Franc. A greater number of DEG were identified for light relative to dark samples (14:00 vs 6:00 or 18:00) and samples collected at temperatures >0C vs <0C. Gene pathway analysis showed significant positive enrichment in hormone signaling and secondary metabolite pathways in both genotypes in the >0C relative <0C temperature conditions indicating transient temperature changes enhance the metabolic activity of dormant buds.

Keywords: bud dormancy, freeze, chilling fulfilment