A Model for estimating the bud hardiness of Chardonnay grown in the Okanagan Valley using Environment Canada's Penticton weather data.

Model (20 May 2020) & Assumptions: This model is based on a 2-day average of daily mean temperature and its deviation from the 2-day average historical mean temperature. (note: model written on Excel)

\*In the instructions references are made to the model using Excel column designations (ie. CF). The workings of the model are identical for all years.

1. At several sites in the Okanagan Valley the bud hardiness of Chardonnay has been measured biweekly from late Oct to early Apr since 2012.
   1. Observation 1 – Grapevine bud hardiness for all varieties follows a similar seasonal pattern where bud hardiness steadily increases in Oct & Nov, is at its maximum with some variation from Dec – Feb, and then steadily decreases in Mar & Apr.
   2. Observation 2 – Measurement of bud hardiness becomes unreliable when hardiness values are -10 °C or warmer. At these temperatures HTE and LTE are too close together.
2. At each site a cane is sampled from 3 of 6 vines with bud hardiness measured on buds 3 thru 7. Bud hardiness values are the mean of 15 buds/site and are expressed as Low Temperature Exotherms at which there is 50% bud mortality (LTE50).
3. In this model the measured hardiness values (LTE50) for each sample date are the average LTE50 from 5 or 6 Chardonnay sites located in Osoyoos, Oliver and Naramata areas.
4. Using a 4th order polynomial equation, a LTE50 curve to describe the average bud hardiness for Chardonnay from Oct 20 to Apr 11 is generated by making a scatter chart plotting the average LTE50 for all 8 years by the date sampled. (to calculate, see tab ‘How to (Chard 4th order poly))
5. From this equation an estimate for daily LTE is generated (Estimated LTE/day CF). In the model 2 assumptions are made:
   1. Assumption 1 – a maximum change in Estimated LTE/day (CG) is set at 0.5°C (Oct 9 – 21).
   2. Assumption 2 – All Estimated LTE/day that are <0.1 to >-0.1 are converted to -0.1 or +0.1. This coincides with the period of max-hardiness and is used as the multiplier for calculating changes in predicted hardiness.
6. A daily 2-day average Temperature Mean is generated (Sept 1 to April 30) from Environment Canada’s Penticton historical Average Temperature Graph.
7. Also for each year 2012-13 to 2018-19 a daily running 2-day temperature mean is calculated from Environment Canada’s Penticton historical weather (Sept 1 to April 30), and this is then used to calculate a daily difference (avg T diff CH) between the historical 2-day average Tmean and the current season’s 2-day average Tmean.
8. Through a series of chained IF statements (CI & CJ) the daily average temperature difference is used to modify an initial Predicted LTE (CK) and LTE/day (CL).
9. These are the first set of limits that keep the initial Predicted LTE from straying too far from the Estimated LTE (CM – CP). These limits are based on the difference of Estimate LTE (CG) and the previous day’s initial Predicted LTE (CK).
10. Setting upper & lower limits to Final Predicted LTE (CR – CV). When near max LTE; cold temp effect on hardiness is small, warm temp effect is large. When significantly warmer than Estimated LTE; cold temp effect on hardiness is large, warm temp effect is small. Final limits are based on the difference of early LTEs and Final Predicted LTE (CW)
    1. Assumption 3 – Predicted LTE50 is based on a 2-day Tmean.
    2. Assumption 4 – the degree and direction of the avg T diff (current 2 day T mean – historical 2 day mean) will positively or negatively affect Estimated LTE/day and is used to generate the Predicted LTE/day.
    3. Assumption 5 – The starting hardiness value on Sep 20 is varied depending on total seasonal GDD accumulation (available Oct. 31st). For cool seasons the diff in GDD (GDD season – GDD average) is multiplied by -0.005. For warm seasons the diff in GDD is multiplied by -0.02.
11. There are 6 sections within each season and the IF statements & limits are written specifically for each section. The sections are as follows:
    1. Sep 21 to Oct 20 – initial hardiness accumulation phase. Bud hardiness increases steadily. Estimated LTE/day grows from -0.15 to -0.50 (this is guesswork as there is no hardiness data available).
    2. Oct 21 to Dec 7 – continuing hardiness accumulation but the rate of hardiness accumulation diminishes daily. Estimated LTE/day changes from -0.50 to -0.10. (note: during acclimation bud hardiness always increases.)
    3. Dec 8 to Jan 6 – period of maximum hardiness where there is a tendency for hardiness to increase to its maximum.
    4. Jan7 to Feb 6 – a second period of maximum hardiness where there is a tendency for hardiness to start decreasing.
    5. Feb 7 to Feb 28 – de-acclimation begins but daily changes to hardiness are still small.
    6. Mar 1 to Apr 11 – de-acclimation continues, bud hardiness decreases rapidly under warmer than average temperatures. (note: in early March 2019 extremely cold temperatures caused hardiness to increase – an unusual event.)
12. On Dec 7 if the initial predicted hardiness (IP) is < -24.5°C it is reset on Dec 8 to -24.5°C.
13. In the first year of the model 2012-2013 there are comments that describe in general the direction and purpose of the IF… and IF(AND… statements.
14. Ideas to improve the model:
15. 2 day mean temp should be recalculated – the 2-day mean should use the morning low temp and the previous day’s high Temp for day 1 and the low Temp from day 1 and high Temp from day 2 for day 2. Currently the model uses the current days high Temp which occurs after the buds have been sampled.
16. Increase the number of sections from 2 to 3 for each period (acclimation, max-hardiness, and deacclimation).
17. Earlier hardiness measurements in the middle of October would increase the confidence of predicted hardiness for late Oct and early Nov.
18. When an Arctic cold front sweeps down through the Okanagan Valley and temperatures drop dramatically in a short period of time it would be interesting to measure bud hardiness daily (a day before, during and after the event) for 3 or 4 consecutive days to see how quickly bud hardiness changes.