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Weather Conditions during Specific Apple Phenological Stages Influence Fruit Quality at Harvest and in Storage

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Introduction

Interannual variability in apple fruit quality at harvest and in storage is often associated with weather conditions during specific phenological stages prior to harvest. Many bioclimatic models that capture this weather variability were implemented in CIPRA (Plouffe et al. 2014), a computer system that uses real time weather data to assist crop producers in their daily decision-making process. Bioclimatic models to assess risks associated with weather conditions are already helpful for apple producers in adjusting their storage and marketing strategies based on forecasted apple quality levels at harvest and in storage.

Weather vs 'McIntosh' and 'Empire' Apples

Apple fruit firmness is one of the main attributes indicating fruit quality at harvest. Weather conditions during apple development are often mentioned for their impact on attributes linked to fruit firmness, i.e. fruit size, calcium concentration, water content, etc. According to Lachapelle et al. (2013a), in a study conducted in Eastern Canada, rainfall from 61 to 90 days from bloom (DFB) and air temperature from 31 to 60 DFB explained 39% and 12%, respectively, of 'McIntosh' apple firmness variation at harvest time (Figure 1). Using phenological periods after bloom greatly enhanced the weather based fruit firmness predictions compared to using calendar days.

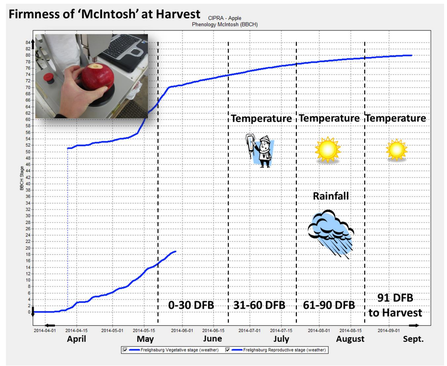

Figure 1. Effect of temperature and rainfall during specific apple phenological stages on 'McIntosh' apple firmnes at harvest (DFB: Days from bloom)

Weather conditions prior to harvest also influence the incidence of many storage disorders. Growing seasons of 1992 and 2000 in Eastern Canada were characterized by lower temperatures and more days with rainfall than average during July and August. Vascular browning, a low temperature disorder observed in 'McIntosh' apples, caused major losses throughout storage during the following winters. Similar problems were observed for 'Ariane' apples in France. Low temperatures and low solar radiations from 31 to 90 DFB were associated with higher vascular browning incidence in 'McIntosh' apples (Bourgeois et al. 2015) (Figure 2A). Predictions of this bioclimatic model are currently used in Eastern Canada to inform producers and managers of storage facilities about risks of low temperature disorders (Figure 2B).

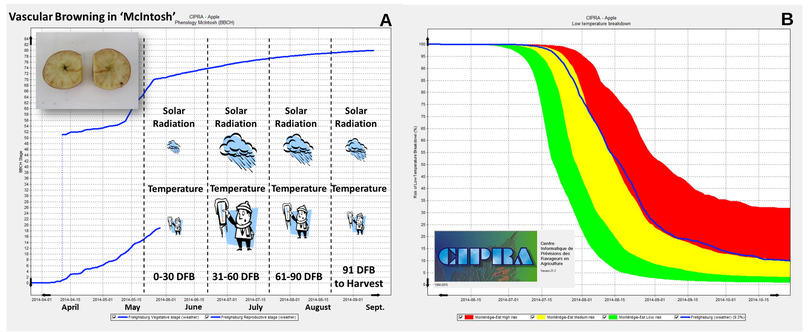

Figure 2. A) Effect of temperature and solar radiation during specific apple phenological stages on vascular browning in 'McIntosh' apples (DFB: Days from bloom); B) Output of the bioclimatic model implemented in CIPRA.

Additional data were collected during 4 years (2010 to 2013) to evaluate the impact of preharvest weather conditions on the development of internal browning and core browning incidences in both 'Empire' and 'McIntosh', with the specific objective of determining when these disorders occur in storage. Data analyses revealed that 'Empire' apples are more sensitive to these disorders than 'McIntosh' and that the disorder occurrence is quite variable from year to year in 'Empire' (Figure 3). The vascular browning risk model, developed for 'McIntosh' apples, was not successful in predicting this year to year variability for internal browning and core browning in 'Empire' apples.

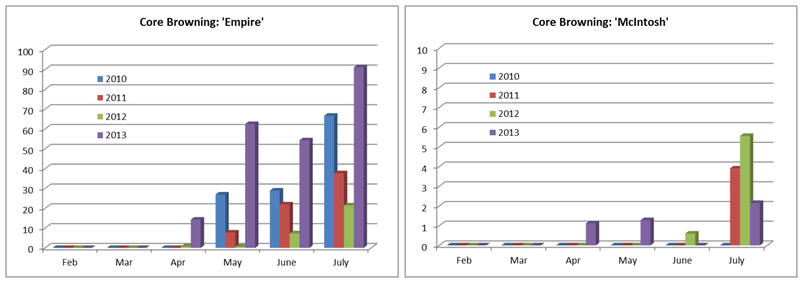

Figure 3. Interannual variability of core browning incidence obtained from monthly storage removals of 'Empire' and 'McIntosh' apples (2010-2013).

Weather vs 'Honeycrisp' Apples

'Honeycrisp' apples show a high susceptibility to physiological disorders such as soft scald and soggy breakdown. Apple phenological data, preharvest data, and storage disorder incidences were collected over many years with the objective of identifying which weather parameters during fruit development influence soft scald and soggy breakdown incidences. Using data from three sites in Ontario, two sites in Quebec and one site in Nova Scotia for three seasons (2009–2011) and four additional sites in Ontario from 2002–2006, Lachapelle et al. (2013b) showed that low temperatures and high rainfall from 0 to 30 DFB explained 20% and 13%, respectively, of the variation in soft scald incidence in 'Honeycrisp' apples (Figure 4A).

Using the same sites and years, recent analyses showed that low temperatures and high rainfall from 91 DFB to harvest explained 36% and 13%, respectively, of the variation in soggy breakdown incidence in 'Honeycrisp' apples (Figure 4B).

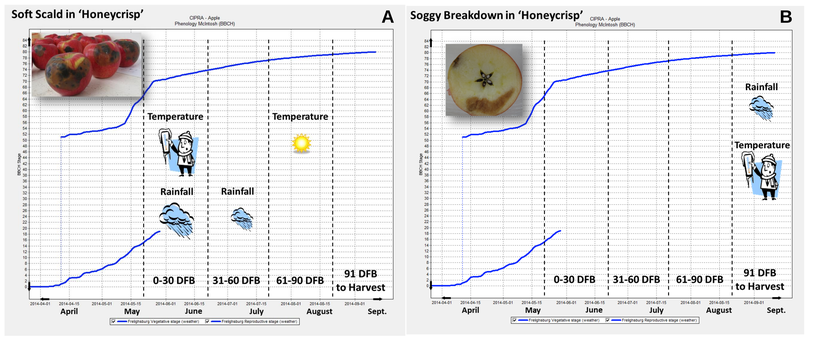

Figure 4. Effect of temperature and rainfall during specific apple phenological stages on soft scald and soggy breakdown incidences in 'Honeycrisp' apples (DFB: Days from bloom)

Conclusions

Even though many of these storage disorders are part of a group called "Low temperature disorders", characterized by browning of internal apple flesh and/or vascular bundles, each of them seems not only to be cultivar specific but also to respond differently to weather conditions at specific phenological stages prior to harvest. Weather based predictions of apple firmness at harvest and risks of physiological disorders before storage are quite useful tools for apple producers in their marketing and storage strategies in order to provide high quality apples to their consumers.

References

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