A process-based model of nectarine quality development during pre- and post-harvest

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Abstract

A new mathematical modeling framework able to simulate the combined effect of fruit growth and post-harvest storage conditions (temperature and relative humidity) on nectarine quality is here proposed. The seasonal course of fruit surface conductance to water vapor, fruit mass loss during storage, and sugar concentration dynamics in fruit pulp were modeled. The three sub-models were integrated into a model capable of calculating a fruit sweetness index and relative water loss during storage, which were selected as nectarine quality criteria. Sub-models parameters were calibrated through results from experiments carried on during 2018 and 2019, where horticultural practices (irrigation and fruit load) and storage conditions were jointly varied. Irrigation level influenced fruit surface conductance to water vapor at harvest, but experimental results point out that this variable may have little influence on fruit mass loss during storage, which was mainly driven by relative humidity in the storage chamber. Irrigation intensity was also influential on sugar dynamics, along with storage temperature, with fruit stored at the higher temperature (25 °C) being sweeter than those stored at lower ones (2 and 15 °C). These experimental results were well replicated by the sub-model outputs. Model simulations during storage revealed a trade-off between the two selected quality criteria, which increased with increasing storage temperature and decreasing relative humidity. The best scenario in terms of acceptable fruit mass loss and sweetness index was for fruit from water-stressed and low crop-loaded trees, 15 °C and 70% relative humidity. Moreover, storage duration was shown to increase fruit mass loss and, to a lesser extent, the sweetness index, while fruit from late harvest dates had higher sweetness at the end of storage. The model can potentially be used to manage and optimize pre-harvest and storage practices that will maximize sweetness and minimize mass loss to meet fruit quality standards along supply chains.