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# Assessing the impact of extreme air temperature on fruit trees by modeling weather dependent phenology with variety-specific thermal requirements

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Extremely high and extremely low temperature may have a terminal impact on the productivity of fruit tree if occurring at critical phases of development. Notorious examples are frost during flowering or extremely high temperature during fruit setting. The dates of occurrence of such critical phenological stages depend on the weather history from the start of the yearly development cycle in late autumn, thus the impact of climate extremes can only be evaluated correctly if the phenological development is modeled taking into account the weather history of the specific year being evaluated. Climate change impact may lead to a shift in timing of phenological stages and change in the duration of vegetative and reproductive phases. A changing climate can also exhibit a greater climatic variability producing quite large changes in the frequency of extreme climatic events.
We propose a two-stage approach to evaluate the impact of predicted future climate on the productivity of fruit trees. The phenological development is modeled using phase – specific thermal times and variety specific thermal requirements for several cultivars of pear, apricot and peach. These requirements were estimated using phenological observations over several years in Emilia Romagna region and scientific literature. We calculated the dates of start and end of rest completion, bud swell, flowering, fruit setting and ripening stages , from late autumn through late summer. Then phase-specific minimum and maximum cardinal temperature were evaluated for present and future climate to estimate how frequently they occur during any critically sensitive phenological phase. This analysis has been done for past climate (1961 – 1990) and fifty realizations of a year representative of future climate (2021 – 2050).
A delay in rest completion of about 10-20 days has been predicted for future climate for most of the cultivars. On the other hand the predicted rise in air temperature causes an earlier development of crops thus a reduction in the length of the different phenological stages. Despite the earlier timing of phenological phases may expose the crops to frost hazard, the mean increase of air temperature avoids relevant impacts on crops. The frequency of air temperatures higher than the cardinal temperatures is expected to increase by 5% compared with the reference 1961 - 1990 climate.

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