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Climate change threatens the viability of temperate fruit orchards in the mediterranean region

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Abstract

Southern Spain and northern Africa have many productive orchards of temperate fruit and nut tree species with high economic relevance. However, these orchards are threatened by rising temperatures both during the main cultivation season and during the winter months. Most temperate-zone trees enter a dormant stage around the time of leaf fall and then require exposure to chilling and heat to resume growth, flower, and ultimately bear fruits. Changes in temperature during the winter can lead to shifts in bloom timing. When agroclimatic requirements are not fully met, trees may show irregular or inhibited flowering, which may entail reduced yield and compromised fruit quality. To project future climate change impacts on Spanish and north African orchards, we calibrated the phenology model PhenoFlex with flowering data of four temperate fruit and nut tree species (apple, apricot, almond, pistachio) from four locations in southern Spain, Morocco, and Tunisia, covering 49 cultivars in total. We predicted bloom dates and potential bloom failure rates (in case agroclimatic requirements are not fulfiled) for present and future conditions. We projected bloom dates and potential bloom failure rates for two periods (2035 – 2065, 2070 – 2100), four climate change scenarios (SSP126, SSP245, SSP370, SSP585), and a collection of global circulation models (14 – 18, depending on the scenario). We observed two main patterns when comparing the projected bloom dates under future and present conditions: unchanged bloom times for almonds in Morocco and moderate to strong delays in flowering for almonds and pistachios in Tunisia, almonds and apricots in southern Spain, as well as apples in Morocco. Additionally, we projected increasing rates of unfulfiled thermal requirements for several apricot cultivars in southern Spain in the short run (2035 – 2065), and for pistachios and almonds in Tunisia and southern Spain in the long run (2070 – 2100) under pessimistic climate scenarios. We observed significant differences among cultivars in the phenology shift and bloom failure rates for apricots and almonds, indicating considerable variation among cultivars in their resilience to warming winters.

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