Evaluation of the effect of global warming on the trend of chilling requirement hours of walnut trees in southern aspect of Alborz mountain range in north of Iran (case study Shahrud region)

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All deciduous fruit trees during cold seasons shed their leaves and enter a state of dormancy to encounter fetal freezing temperatures. Before the end of dormancy, they require to accumulate a certain amount of winter cold hours (chilling requirement) to start blooming and setting fruit by increase of air temperature to above a certain point. Chilling requirement hours for most fruit trees accumulate from 0ºC to 7^{0}C. Global warming in many marginal temperate regions might fail to provide chilling requirements for many deciduous fruit tree cultivars.

The chilling and heat requirements of 10 almond cultivars for flowering time examined (Egea et al., 2002). The results showed that flowering time of different genotypes of almond is mainly a consequence of the chilling requirements, while the heat requirements contribute much less influence. Luedeling et al. (2009) validated winter chill models using historical records of walnut phenology. They used this method on 1297 phenological observations, including four walnut cultivars, seven phenological stages and eight locations in California. By employing four chilling models and using an hourly temperature record, winter chill was quantified and remaining heat was estimated using the Growing Degree Hour concept. The results clearly revealed that the Dynamic model was highlighted as the most accurate tool for quantifying winter chill. Therefore, the aim of this research was to evaluate the trend of chilling requirements of walnut tree varieties in the south aspects of Alborz mountain range in Shahrud region, north of Iran, for different climate change Scenarios.

For this purpose, using the CanESM2 general circulation model and downgrading SDSM software, the maximum and minimum temperature data constructed for 2006-2099 period, and the Representative Concentration Pathway (RCP) scenarios of RCP2.6, RCP4.5, and RCP8.5, which represents optimistic, middle and pessimistic predictions, respectively, was employed. First, the generated temperature data converted to hourly values from daily data using bi-sinusoidal model. Then chilling requirement hours estimated from hourly temperatures by employing chilling hours, Modified Utah and Positive Utah methods. Since the global warming has a positive trend, the selected period of 2006-2099 divided into three intervals of 2006-30, 2030-75, and 2076-99. Using chi square test (χ^2 test) predicted minimum and maximum temperatures, and chilling requirement hours of the three interval periods compared with the corresponding values of the baseline period (1966-1995).

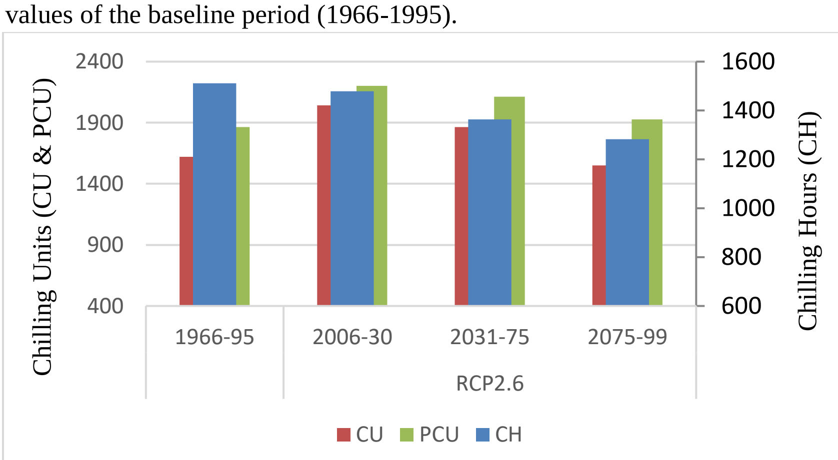

Figure 1. Chilling values variations in different models (CU, PCU & CH) compared with the baseline in RCP2.6

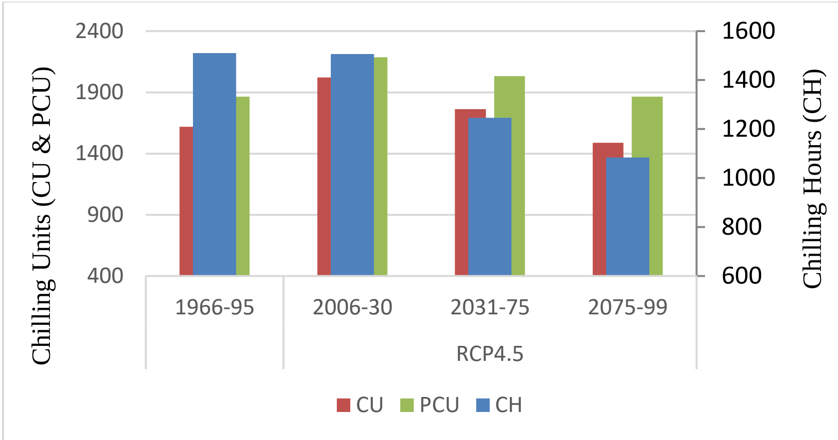

Figure 2 Chilling values variations in different models (CU, PCU & CH) compared with the baseline in RCP4.5

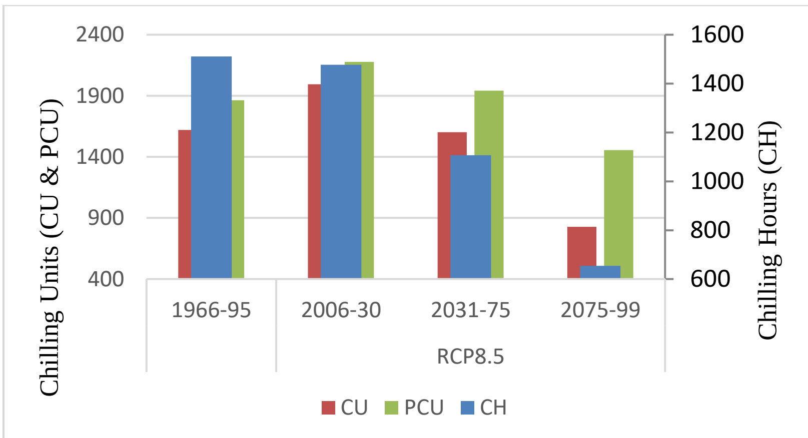

Figure 3 Chilling values variations in different models (CU, PCU & CH) compared with the baseline in RCP8.5

The results show that the predicted maximum and minimum temperatures of RCP4.5 and RCP8.5 scenarios for all three intervals were significantly different from baseline period (1966-95). While for these parameters, there were no significant differences between 2030-75 and 2076-99 with baseline using RCP2.6 scenario. These findings are in consistent with the large-scale projections of this optimistic scenario. Reduction of chilling requirement hours with Chilling Hours model (0-7 °C) is in harmony with the trend of global warming. While with Utah's models (modified and positive), during the 2006-2030 interval, the predicted accumulated chilling hours increases in compared with the baseline values, but decreases again in subsequent intervals, which is in agreement with the level of pessimism of each corresponding scenario(see figures 1, 2 and 3). These variations in chilling hour trend might be due to the amount of predicted cloudiness, which could be a source of uncertainty.

References:

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