Can forcing partially substitute for lack of chilling?

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Lack of chilling, a cold temperature period during winter, is a pre-requisite for most temperate zone fruit trees such as apple, pear, plum, peach, cherry and apricot (Kaufmann and Blanke, 2017a. With the onset of recent climate change, horticultural production of these fruit crops has been hampered or affected due to milder, warmer winters (Blanke and Kunz, 2009) and lack of chilling, but possibly more forcing. The Mediterranean climate zones have been particularly affected by this phenomenon (Kaufmann and Blanke, 2017b). Year to year variation is still abundant and provides years with and without lack of chilling, with a tendency to more years/winters with a lack of chilling. The research presents 4 year experiments with 160 potted intact cherry trees of three cultivars with a 3fold difference in chilling requirement (500, 1000, 1500 CH) exposed to 8 scenarios. In the literature, substitution of chilling by forcing and versa vice is often postulated, but no proof and/or exact figures of their magnitude given (Kaufmann and Blanke, 2017c). Hence, the objective of the research was to investigate how much lack of chilling can be substituted by more forcing and elaborate practical means of overcoming lack of chill in the orchard with emphasis on med climate.

Materials and methods

The experiments were carried out at Klein-Altendorf experimental station (50°N) of the University of Bonn, Germany. The 160 fully grown cherry trees were grafted on dwarfing GiSelA 5 rootstock and planted in 35 litre pots, probably the largest chilling experiment worldwide. The cherry varieties selected were 6000CZ, a Californian variety with ca. 500 CH and 'Brooks' with ca. 1,000 CH. Cherry cv. 'Schneiders Späte Knorpelkirsche' was used as a high chill variety with up to ca. 1,500 CH when grown in Germany, but ca. 800-1000 CH when grown under its synonym 'Ziraat' in Turkey. Trees were subjected to one of 8 scenarios, by placing them either in the field/orchard or an unheated greenhouse (to simulate climate change). Whole trees were then transported into a heated greenhouse for forcing and flowering assessment. The 8 scenarios included 50% less, optimum (reference value = 100%) and 50% chilling, the latter to understand the mechanisms of chilling, explore the physiological responses of trees in areas where chilling increases (Russia, Scandinavia).

Results

Relation between chilling and forcing

The results of the comprehensive experiments can be visualised as follows and show that a minimum degree of chilling has to be fulfilled before warmer temperatures (Forcing) become effective and b) forcing commences well before chilling ceases (Fig. 1).

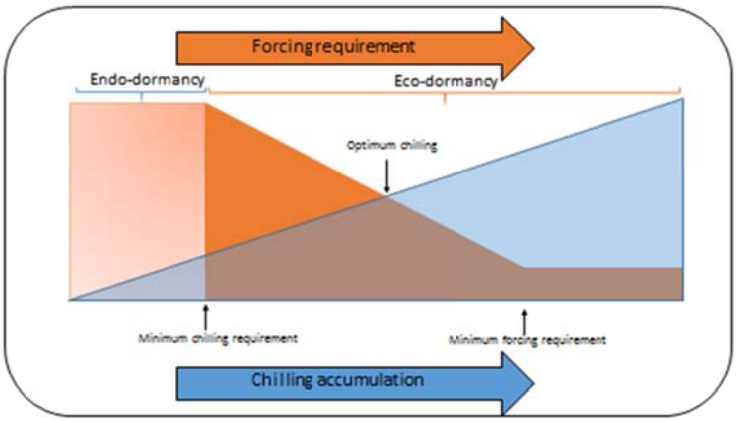

Fig. 1 shows the sequence of chilling and forcing and possibilities of substituting lack of chilling, to some extent, by more forcing

Rate of substitution of lack of chilling by forcing

The results of the 8 scenarios also showed that Forcing can successfully compensate inadequate chilling levels at 50-100% of optimal chilling at ratios GDH to CH or CU of <15:1 for high chill varieties, <20:1 for medium chill varieties and <25:1 with low chill varieties.

With optimum chilling, the optimum forcing for cherry was ca. 8.000 GDH (>12 °C), irrespective of variety employed, and irrespective of scenario (-50% to +50% chilling). The basis of this threshold of 8,000 GDH of forcing maybe a useful requisite for horticulturists to calculate and predict effects of insufficient (and even excessive) chilling. Up to 50% of chilling can be compensated by forcing. This may enable a comparison of cherry and other varieties as their suitability of cultivation in a particular location and possibly predict flowering. If more than 8,000 GDH are needed for full bloom, chilling availability declines for those varieties and vice versa.

Adaptation strategies

Proposed adaptation strategies for to overcome lack of chilling in the med climate are: a) Relocation of fruit orchards to hillside with more chilling; b) selection of low-chill varieties and c) cooling during warm winter periods by shading, netting or evaporative cooling, which will be shown in photos in the presentation.

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Reference list

Blanke, M.M., Kunz, A., 2009. Impact of recent climate change on pome fruit phenology at Klein-Altendorf-Einfluss rezenter Klimaveränderungen auf die Phänologie bei Kernobst am Standort Klein-Altendorf – anhand 50-jähriger Aufzeichnungen]. Erwerbs-Obstbau 51 (3):101–114

Kaufmann, H., Blanke, M.M., 2017a. Chilling in cherry – principles and projection – a brief introduction. Proc COST cherry FA1104 Working Group 2 (‘Cherry phenology and climate change’). ISHS Acta Hort 1162:39-44 DOI: 10.17660/ActaHortic.2017.1162.7

Kaufmann, H., Blanke, M.M., 2017b. Performance of three numerical models to assess winter chill for fruit trees- a case study with cherry in Germany. Reg. Environ. Change 17, (3): 715-723. doi: 10.1007/s10113-016-1064-6

Kaufmann, H., Blanke, M.M., 2017c. Changes in carbohydrate levels and relative water content (RWC) to distinguish dormancy phases in sweet cherry. J. Plant. Physiol. 218: 1-5 DOI: 10.1016/j.jplph.2017.07.004