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Editorial

Orchard Management Under Climate Change

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Health-conscious consumers are looking for healthier foods that promote health and well-being. Fruit stands out and is recognized for its nutritional value, with considerable levels of fibre, minerals, phenolic content, other antioxidant substances, vitamins and other nutrients [1]. Expanding fruit crops can help increase food production and consequently reduce food insecurity and hunger around the world [2], as well as generating employment and income along the production supply chain.

Hundreds of fruit species are spread across continents all over the world. Dozens of the best fruits, produced in regions with specific climates and soils and distinct vocations, supply the global market and find their place in competitive international trade [3]. Almost every type of fruit on the planet is harvested in the tropics and temperate zones, which explains how much of the land of micro, small, medium and large commercial farms is identified as orchards [4]. Like agribusiness as a whole, this sector is cutting costs wherever possible and planning for extreme efficiency in operations, but harvests are only viable if plantations are well looked after. Meanwhile, export sectors benefit from the exchange rate, turning crises in some sectors into opportunities for growth in others [4].

Climate is one of the most important limiting factors for fruit production and climate change is currently the biggest threat to the environment [5,6]. A shortage or excess of rainfall, extreme temperatures, hail and frost are affecting fruit crops all over the world. In this context, it is necessary to continually assess the long-term evolution of climatic factors and their influence on the production and quality of fruit worldwide [7].

Climate change is a very topical and relevant issue for orchard management and has been addressed in different ways in this Special Issue. A series of articles are presented on various topics of cultural practices in orchards under different climatic conditions and with different fruit trees and the impact of climate warming on vineyard crops. Eight research articles and two reviews were briefly described in this Editorial. The main aim was to motivate readers to further explore the articles.

Raspberries (*Rubus idaeus* L.) are originally grown in temperate climate regions. Increased market demand for fresh raspberries, however, has led to the development of new strategies to supply the market with this fruit all year round, with production outside the main harvest season and the expansion of growing areas to warm climate regions [8]. Medina et al. (contribution 1) evaluated the cultivation and pruning systems for primocane raspberries in a subtropical climate in the state of São Paulo, Brazil, where raspberry production is limited to high latitude cool temperate areas due to the need for low temperatures for flowering and fruiting of most cultivars. Nevertheless, primocane cultivars, which are less demanding in terms of cold conditions, represent a possible alternative that adapts to

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subtropical climate regions. The results show that the Heritage raspberry cv. Primocana can be grown in the subtropical Cwa climate with sequential pruning, allowing the production of commercial fruit with harvests distributed over the year, without reducing the post-harvest quality of the fruit produced.

Ongoing studies are needed to ensure that wine production in Brazil is optimized. The relationship between the variety, rootstock and trellis height is important for vine management, especially for the production of new varieties of grapes for juice and wine in new wine-growing regions with high production potential. The choice of training system depends on the architecture and physiological characteristics of the vines, affecting the production and quality of the grapes [9]. Domingues Neto et al. (contribution 2) studied the production and quality of Brazilian hybrid grapes according to the rootstock and training system in the state of São Paulo, Brazil. The high trellis system provided the overall most effective results, increasing the photosynthetic rate, improving water use efficiency, increasing vine production and improving fruit quality. The authors recommended its use for training vines. With regard to rootstocks, the best compatibility between scion and rootstock was found between hybrid vines and 'IAC 766 Campinas'.

Following the same research, the effects on photosynthesis, biochemistry and production performance of grapevine hybrids on two rootstocks and trellis heights were evaluated in the Cfa climate of São Paulo state, Brazil, by Domingues Neto et al. (contribution 3). The rootstock and trellis height combination had a positive effect on the variables evaluated. In summary, under subtropical conditions, better photosynthetic, biochemical and productive performance was observed when the cultivars IAC 138-22 Maximo and BRS Violeta were grafted onto the rootstock 'IAC 766'. 'IAC 138-22 Maximo' was trained at 2.0 m and grafted onto 'IAC 766' rootstock, increasing grape production and photosynthesis efficiency. In addition to this, this variety was more productive than 'BRS Violeta'.

The sustainability of citrus crops is a global matter of interest. Brazil is among the countries that are vulnerable to cultivating a reduced number of citrus genotypes, which leads to greater susceptibility to pests and diseases, as well as lower economic competitiveness [10]. New combinations of scion/scion cultivars are a constant need for citrus growers and are also aimed at satisfying the preferences of consumers, who are increasingly demanding in terms of the quality attributes of the fruit and the orange juice consumed. There is currently a growing demand for nutritious food and many attempts have been made to maximize nutrient retention during storage and during processing. Martins et al. (contribution 4) explored the profile of bioactive compounds in orange juice as a result of using different rootstocks, packaging and storage. The research insights can contribute to the diversification of scion/rootstock cultivars in hopes of increasing orchard variety by choosing the best combinations for pasteurized orange juice with the highest nutritional value.

An important topic presented studies on the tropicalization of hops in subtropical conditions (contribution 5). The interest in hop production in Brazil, motivated by the third position in the world ranking of beer producers and the growth of the craft brewery business, justifies the intensification of studies on its adaptation to local cultivation conditions. Considering the high internal demand and expansion of the national beer market with interest in hops with peculiar phytochemical profiles, studies that promote the expansion of new cultivation zones and that guarantee quality are very desirable. Fortuna et al. (contribution 5) investigated the chemical compositions of varieties grown in organic and conventional systems in the state of São Paulo in Brazil. This study contributes the first report of the chemical profiles of hops grown in subtropical conditions.

Climate change is threatening wine production everywhere, especially in regions with hot, dry climates. The risks of frost and drought during the growing season are common problems in viticulture. Therefore, maintaining viticulture also requires adapting

to climate change, and the evaluation of adaptation strategies needs to be more precise and multidisciplinary and adapted to specific local conditions [4].

Vrši ˇc et al. (contribution 6) examined the structure and trends of climatic parameters important for grape production over seventy years in Slovenian wine regions. Mean and extreme temperature and precipitation data from six meteorological stations in three wine regions were divided into annual and growing seasons. The trends show a decrease in total annual precipitation.

Vrši ˇc et al. (contribution 7) also reported on the impact of climate warming on the early ripening of wine grapes in north-eastern Slovenia. In this study, the development trends of bioclimatic parameters recorded over seventy years and the dynamics of grape ripening in early, medium and late ripening grape varieties were investigated. Based on the data on soluble solid content, total acidity and the recommended harvest date per year, the trends in the reduction in the growing period of the vines were calculated. Temperature changes were more pronounced and the number of so-called hot days (with a maximum T > 30 °C) increased the most, which has the greatest impact on other bioclimatic parameters, for example, average temperature and growing degree days. Total annual rainfall and rainfall in the growing season show downward trends.

Filimon et al. (contribution 8) highlighted the changes in the main climatic elements during the last five decades (1971–2020) in north-eastern Romania and their impact on grape quality, as part of precision viticulture strategies and efficient management of vine orchards. The main outcomes indicated a significant increase in the values of the bioclimate indicators, requiring the reclassification of the viticulture area into higher classes of favorability, increasing the opportunity to grow cultivars more suited to warmer climates, ensuring the efficiency of the vineyard and meeting the current consumer demands.

In this Special Issue, selected topics on the perspectives, challenges and sustainability of orchard management under climate change are covered. Sustainable agricultural practices need to be continually sought so that a greater number of producers can adopt them, taking into account, above all, the food security scenario, land-use efficiency and climate change.

Leonel et al. (contribution 9) reviewed recent findings on banana-based intercropping systems. The authors provided an overview of studies on intercropping banana plantations, focusing on the contextualization of land use, monoculture and intercropping, and evaluating intercropping indicators, as well as the benefits, risks and disadvantages discussed in the literature and the main results of banana-based intercropping systems. The main conclusions relate to the use of combined crops with aromatic species and preliminary reports on the contributions of intercropping to the suppression of Fusarium wilt disease.

Jaffar et al. (contribution 10) presented an important review article that provides an overview of the invasion history of B. dorsalis in China, its ecological and physiological mechanisms that facilitate invasion, and the progress made in understanding its main biological characteristics. Bactrocera dorsalis (Hendel, 1912) (Diptera: Tephritidae), commonly known as the oriental fruit fly, is a highly destructive pest that infests fruit and vegetables worldwide, resulting in economic losses every year. The main B. dorsalis management approaches that have been or are likely to be implemented in China were presented, including quarantine measures, monitoring procedures, physical controls, biological controls, the sterile insect technique, RNA interference and CRISPR-Cas-9.

Given the great importance and relevance of the theme of this Special Issue, ongoing studies should be encouraged and rapidly publicized, allowing readers to find research in global and national contexts that provides a more complete overview of the field of research into climate change affecting the growth, yield and qualitative performance of fruit orchards.

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