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Editorial

Response to Abiotic Stresses in Horticultural Crops

Adalberto Benavides-Mendoza [1,*], Yolanda González-García [2], Fabián Pérez-Labrada [3] and Susana González-Morales [4]

[1] Department of Horticulture, Universidad Autónoma Agraria Antonio Narro, Saltillo 25315, Mexico
[2] Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Centro de Investigación Regional del Noroeste, Campo Experimental Todos Santos, La Paz 23070, Mexico; gonzalez.yolanda@inifap.gob.mx
[3] Department of Botany, Universidad Autónoma Agraria Antonio Narro, Saltillo 25315, Mexico; fabian.perezl@uaaan.edu.mx
[4] CONAHCYT-UAAAN, Universidad Autónoma Agraria Antonio Narro, Saltillo 25315, Mexico; sgonzalezmo@conahcyt.mx
* Correspondence: adalberto.benavides@uaaan.edu.mx

1. Introduction

Horticultural production systems provide multiple benefits: economic, social, and health. However, the climate crisis poses a significant potential impact on horticultural production, due to changes in weather patterns and various environmental stresses [1]. Despite the expansion of protected horticulture in recent decades, crops grown in greenhouses, on mulches, and under shade nets are not immune to the adverse effects of these stresses; furthermore, a substantial portion of horticultural crops, in terms of area and production volume, are cultivated in open fields. Therefore, research on the impact of abiotic factors on the productivity, quality, and yield of horticultural crops is crucial [2].

Recently, the study of abiotic stress in horticultural crops has gained significant attention, reflecting the growing need to understand and mitigate the negative effects of environmental stressors on crop productivity and quality. Abiotic stresses such as drought, salinity, extreme temperatures, and heavy metal contamination are major limiting factors in horticultural production. These stresses can adversely affect plant growth, development, and yield, leading to substantial economic losses and threats to food security. Recent developments in the field of horticultural plant stress have underscored the intricate interplay between environmental stressors and plant physiological responses, leading to innovative strategies for improving crop resilience and productivity [3].

The study of stress in crops can be approached from different points of view. One angle to begin from is the consideration of elements that make up the agroecosystem, such as soils and water. This can be used in the field of plant populations or in the physiology and biochemistry of individual plants. Similarly, analyzing agronomic management or using biostimulants constitutes a valuable approach to understanding and improving crop responses to stress. All these elements were covered by the articles published in this Special Issue, which demonstrates the scope of the efforts made by the scientific community to address the problem of horticultural crop stress. Below is a review of the published studies in the Special Issue.

2. Overview of Published Articles

In horticultural production systems, soil serves as the fundamental medium for plant growth and development, and its physicochemical properties are crucial external factors that influence these two aspects. In the first paper of the Special Issue, Gu et al. (Contribution 1) studied the growth of *Zanthoxylum armatum* in five different types of soil, namely, red soil (RS), yellow soil (YS), acidic purple soil (ACPS), alkaline purple soil (ALPS), and alluvial soil, which exhibited distinct physical and chemical characteristics due to variations in their formation processes and nutritional conditions. The results indicated that the

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morphological indices of the *Z. armatum* seedlings grown in the alluvial soil were greater than those in the other four soils. Because of the relatively high nutrient levels in the plant organs, alluvial soil and red soil may be advantageous for cultivating *Z. armatum*. The above findings aid our understanding of how this plant adopts various nutrient acquisition strategies under different soil conditions.

The application of microbial biostimulants is a valuable and increasingly used activity in soils and horticultural plants. Plant growth-promoting rhizobacteria are capable of inducing a tolerance to abiotic and biotic stresses. A report by Andy et al. (Contribution 2) assessed the potential of two isolated rhizobacterial strains of *Bacillus* possessing PGPR capabilities. The different tests on the production capacity of metabolites and enzymes with a biostimulant capacity under conditions of stress, due to water deficit and in the presence of heavy metals, indicated the potential of these strains to improve the response of plants to stress.

Horticultural species that produce metabolites with medicinal value constitute a valuable sector of the industry. These species respond to stress factors by modifying their composition and varying their quality and medicinal potential. In a study reported by Honório et al. (Contribution 3), *Annona emarginata* was subjected to three water levels (flooding, field capacity, and drought) for two periods of time (stress and recovery), which significantly modified the primary metabolism and impacted the accumulation of metabolites with medicinal value; drought promoted a higher concentration of total alkaloids and flooding lead to a decrease in total alkaloids and an increase in the liriodenine concentration. This study revealed that different kinds of stress can constitute tools for controlling the composition of medicinal plants. Conversely, following the same topic of medicinal plants, Vinogradova et al. (Contribution 4) presented a review with a complete overview of the impact on health, therapeutic potential, and production of medicinal plants when they are subjected to heavy metals, whether from natural sources or anthropogenic pollution. This topic is relevant considering the great horticultural importance of medicinal plants and the growing popularity of herbal remedies.

Cold damage can reduce the value of climacteric fruits and cause losses in the commercial chain when they are handled postharvest. Sensitivity to low-temperature damage varies between species and between varieties within species. However, the mechanism that causes the difference in sensitivity is poorly understood. In the study published by Zhan et al. (Contribution 5), two types of peach fruits (cold insensitive and cold sensitive) were selected for an analysis of the mechanisms of chilling injury in fruits with varying levels of chilling sensitivity. This analysis utilized lipidomic and transcriptome data and dynamic changes in plant hormones. In cold-insensitive peach fruits, the endogenous ABA and dilactosyl diacylglycerol contents significantly increased during low-temperature storage. In contrast, cold-sensitive peach fruits accumulated higher levels of ethylene, phospholipids, and ABA glucose esters than CM fruits, explaining the observed severe symptoms of the cold stress.

Heavy metals represent a significant stress factor for crops, a problem exacerbated by pollution from industrial waste and hydrocarbon combustion. The relationship between tomato growth and the ability to accumulate cadmium (Cd) in different organs was reported by Zhang et al. (Contribution 6). The authors found that while roots absorb and transport metal, they do not serve as storage organs. Additionally, plant growth did not influence the Cd concentration in tomato tissues. The highest Cd concentration was found in the leaves, followed by the stems and then the fruits. The results are valuable for projects focused on selecting cultivars with a low rate of metal transport to fruits. Similarly, Pérez-Labrada et al. (Contribution 7) described how the biostimulants citric acid and humic substances modify the absorption of Fe in tomato plants using different physiological, biochemical, and gene expression variables. Both biostimulants favorably modified the variables under study and improved the response of the plants that grew in calcareous soil.

Water deficit and salinity are increasingly common stresses affecting horticultural activity. Therefore, the use of and research on tolerant fruit-producing species are considered essential. Kenanoğlu et al. (Contribution 8) investigated the impact of two different pitaya

species and different biostimulants applied for seed priming on the tolerance of plants to salinity. The pitaya species was a determining factor in tolerance, while oxalic acid and mepiquat chloride were the best inducers of tolerance. This study is relevant for the genetic improvement of this species. With respect to salinity, Širić et al. (Contribution 9) described the impact of TiO_2 nanoparticles and biochar on Chinese spinach under salinity stress. The authors found a synergistic effect in the two biostimulants, indicating that the combination of nanomaterials and conventional biostimulants is an area that should receive greater attention from researchers.

Studying the adaptive mechanisms of halotolerant species is important for developing strategies to improve crop responses to soil salinization. Joshi et al. (Contribution 10) described the mechanisms used by two halophytic species of the genus *Suaeda* to tolerate high levels of Na^+, Cl^-, and heavy metals. Changes in the ionic composition of the cells, the accumulation of osmolytes, and the improvement in antioxidant metabolism were part of the metabolic adjustments made by the plants.

One of the challenges of climate change and the destruction of ecosystems is biodiversity conservation. Micropropagation is a technique that allows the propagation of plant material from rare or endangered species. Chokheli et al. (Contribution 11) published an article describing the development of an optimization method to obtain the appropriate medium for propagating rare species.

3. Conclusions

The scope of the Special Issue is broad, and includes different approaches to studying and improving the response of different horticultural species to stresses from factors such as low temperature, salinity, water deficit, heavy metals, and micronutrient deficiency. However, some important stresses, such as high temperature and high irradiance, which are common in many places where horticultural species are grown, were not included.

Despite the above, the Special Issue presents a complete overview of information for those interested in research, the development of biostimulants, or horticultural production in the field.

Conflicts of Interest: The authors declare no conflicts of interest.

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