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Editorial

Horticultural Plants Facing Stressful Conditions—Ways of Stress Mitigation

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1. Introduction

Rapidly progressing climate change is increasing the frequency and severity of drought and salinity stresses, which are the major factors affecting crop production and the quality of ornamental plants, fruits, and vegetables. Natural acclimation and adaptation mechanisms of plants may not be sufficient to cope with these swift climate changes, and plant yield may be reduced and have a lower quality. For this reason, it is necessary to look for ways to reduce the negative effects of stress to provide constituents of the human diet in sufficient quantity and quality. Scientists are investing efforts toward the development of new cultivation techniques and improvements in the nutritional and pro-health value of fruits and vegetables.

The present treatise examines selected topics relating to stressful conditions and ways of its mitigation. The findings of these studies is especially important in understanding the molecular, metabolic, and genetic basis upon which to increase the plant resistance to environmental stresses. This Special Issue comprises twelve research papers and one review. The review article focused on the influence of salt stress on plant growth and methods of its reduction. The presented research studies were conducted at the morphological, anatomical, physiological, and molecular levels. The authors described the impact of stress caused by salinity [1–7], high temperature [8,9], drought [9], spring frosts [10], copper [11], asbestos [12], and biotic stress [13]. Different plant species were studied, i.e., sunflower, zinnia, orchid, buttercup, tomato, snap bean, lettuce, jojoba, grapevine, strawberry, and apple. This Special Issue is dedicated to the following topics: (1) the application of exogenous compounds and bioinoculants to increase stress tolerance [1–7,9,13], (2) the improvement of fruits and vegetables quality and their nutritional value [2,7,10], and (3) the planting of ornamental plants in polluted areas [1,11,12]. Interestingly, Markulj Kulundžić et al. [8] showed that daily changes in temperature and light intensity can induce unfavorable changes in the process of photosynthesis. They observed that morning environmental conditions were optimal for photosynthetic responses of sunflower in the flowering stage, while the afternoon was characterized by elevated temperatures and excess light intensity.

2. Exogenous Compounds and Bioinoculants Increasing Stress Tolerance

Various studies indicated that application of exogenous compounds can serve as an alternative to mitigate salt stress in commercial cultivars. Eisa et al. [1], El-Beltagi et al. [5], and Annadurai et al. [9] found that melatonin application decreased the negative effect of salt, drought, and high-temperature stresses, respectively. They recognized that melatonin, as a novel biostimulator, has potential in scavenging reactive oxygen species through increased antioxidant activity, which shields the photosynthetic membrane from damage and therefore helps toward stress mitigation. Melatonin was found to have a positive effect at the morphological, physiological, and biochemical levels. In accordance with expectations, plant growth [1,9], fruit yield [9], photosynthetic rate [9], the activity of antioxidant enzymes, such as superoxide dismutase, catalase, peroxidase, ascorbate peroxidase, and glutathione reductase [1,5,9], and the contents of free proline [1,5], chlorophyll, carotenoids [1,5,9], and total soluble sugars [5] were increased in stress- and melatonin-treated plants. Moreover, El-Beltagi et al. [5] demonstrated that a combined treatment of melatonin and putrescine could enhance resistance to salinity in snap bean seedlings.

Aboryia et al. [4] evaluated the effect of foliar-applied proline on the enhancement of jojoba tolerance to salt stress. The physiological responses to proline treatment were manifested by an increase in the content of chlorophylls, carotenoids, minerals (N, P, K, Na, and Cl), and phenols in leaves, as well as the promotion of the antioxidant system compared with the control plants. Also, the exogenous application of proline improved most morphological (e.g., shoot number, stem diameter, number, area, and weight of leaves) and anatomical characteristic of jojoba leaves in saline conditions. In turn, Sayed et al. [2] used nano-silicon fertilizer to mitigate salinity stress. They observed that nano-silicon application on the leaves of tomato plants (*Solanum lycopersicum* L. grafted on *S. pimpinellifolium* or Edkawy) enhanced shoot and root growth, fruit yield, and fruit quality. Higher levels of mineral content, gibberellic acid, abscisic acid, and proline were detected in shoots that were grafted and subjected to nano-silicon application compared to the control treatment.

Polyhydroxy steroids phytohormones, such as brassinosteroids, can also be used to improve crop salt tolerance [6,7]. Furio et al. [7] found that strawberry treated with brassinosteroids was characterized by a higher shoot and root weight as well as a higher total weight of fruits per plant. Additionally, the quality of fruits obtained in salt stress conditions after brassinosteroids application was significantly higher than in non-treated individuals. Also, El-Banna et al. [6] indicated that grapevine seedlings sprayed with brassinosteroids tolerated salt stress better by sustaining higher photosynthetic pigment concentrations, maintaining ion homeostasis and water status, and stimulating antioxidant capacity, as well as affecting the preservation of the proper leaf anatomical attributes compared to untreated plants.

Stressful conditions can also be alleviated by using bioinoculants, which can offer a crucial alternative for organic farming [13]. Bioinoculants are a group of microorganisms which promote plant growth by making essential nutrients more bioavailable, control phytopathogens and disease development (biotic stress) as biocontrol agents, or increase tolerance to pollutants (abiotic stress). Pacheco-Trejo et al. [13] described the possibility of using *Trichoderma* spp. to protect and stimulate the growth of horticultural crops. They proved that the plant signaling events triggered by *Trichoderma* spp. are of high importance in order to understand the molecular basis involving plant protection against stresses. Also, the signaling elements of the plants from *Trichoderma* perception through late defensive responses were described. The authors explained that the activation of defense in plants stimulated by *Trichoderma* spp. will lead to an increase in crop production with consequent benefits for human health and the environment.

3. Improvement in Quality and Nutritional Value of Fruits and Vegetables

Plants exposed to various stresses deliver a lower crop production and quality of edible plants. Furio et al. [7], Ozherelieva et al. [10], and Maglione et al. [3] were looking for ways to prevent the negative effects of stress and maintain the good quality of harvested fruits and vegetables. They proposed brassinosteriods [7], iodine [3], and adaptogenic preparations [10] as protective factors against stress with the ability to improve the quality of potential yields.

Furio et al. [7] demonstrated that a pre-harvest treatment with brassinosteriods promoted the growth of strawberry in normal conditions and under exposition to water or saline stresses, as well as evaluated the percentage of fruits of commercial quality. In turn, the results of Maglione et al. [3] showed that positive stress (eustress) or essential and non-essential elements can improve the nutritive values (biofortification) of lettuce. Iodine application under moderate salinity increased the amount of the bioactive compounds acting as antioxidants, e.g., polyphenols and anthocyanins, thus exercising functional effects on human health.

Ozherelieva et al. [10] estimated the suitability of the adaptogenic preparations (phytomodulator "White Pearl Universal Antifreeze" and phytocorrector "White Pearl Drip Ca + Mg") to increase the yield and quality of apple cultivar "Sinap Orlovsky". The foliar application of these products in the early spring period significantly reduced the effects caused by scald in fruits, decreased bitter pitting, increased the average fruit weight, as well as increased the amount of sucrose and L-ascorbic acid, thus improving the taste qualities of fruits.

The conducted research including brassinosteriods [7], iodine [3], and adaptogenic preparations [10] proved their validity as additional techniques in traditional cultivation technologies, thus inducing a higher production and better quality of crops.

4. Planting Ornamental Plants on Polluted Areas

Heavily polluted areas lose their suitability both as agricultural lands and as ecological lands. The accumulation of toxins limits the growth of plants and hinders their revitalization. The constant increase in contaminated areas forces us to seek new opportunities for their cleanup and re-use.

Tugbaeva et al. [11] proposed to use *Zinnia elegans* (Jacq.) in landscaping because they observed that it performs well in copper-polluted growth medium (200 μM $CuSO_4$). The adaptation of zinnia to the excess Cu was associated with the metabolic changes in the phenylpropanoid pathway. The intensified lignification in the roots led to the accumulation of Cu in this organ and limited translocation to the shoots, which provided plant growth. An increase in the content of H_2O_2 and intensity of lipid peroxidation, as indicators of stress, an elevated amount of phenolic compounds, as well as the level of expression of genes encoding 4-coumarate-CoA ligase, cinnamoyl alcohol dehydrogenase, and class III peroxidase were observed under Cu treatment.

The possibility of *Epipactis atrorubens* (Hoffm.) cultivation on serpentine dumps post asbestos mining was analyzed by Maleva et al. [12]. The aim was the naturalization of regionally rare orchid species, very beautiful bright flowers, in contaminated areas. The authors observed that the leaves of orchids colonizing these dumps accumulated lipid peroxidation products, ascorbate, free proline, soluble phenolic compounds (including flavonoids), and non-protein thiols. For this reason, they recognized that non-enzymatic antioxidants increased the adaptive potential of *E. atrorubens*. They also attributed an important role to the increased mycorrhization of orchid plants growing under adverse conditions.

In addition to studying the adaptation of plants to growth in a saline environment and the response to this stress, Eisa et al. [1] also studied the possibility of alleviating stress using melatonin. The subject of the study was buttercup (*Ranunculus asiaticus* L.), highly prized as a cut flower due to its very decorative inflorescences. It was found that the foliar application of melatonin decreased the salt-induced symptoms of retarded vegetative growth, improved physiological parameters, and soothed oxidative stress, thereby enhancing stress resistance, which can be considered as an effective practice for production under stress conditions.

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