1874-3315/22 *Send Orders for Reprints to reprints@benthamscience.net*

The Open Agriculture Journal

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EDITORIAL

Plant Adaptation to Changing Environment and its Enhancement

Yuriy E. Kolupaev[1,2,*] and Yaroslav B. Blume[3]

[1]*Dokuchaev Kharkiv National Agrarian University Kharkiv, Ukraine*
[2]*Yuriev Plant Production Institute, National Academy of Agrarian Sciences of Ukraine Kharkiv, Ukraine*
[3]*Institute of Food Biotechnology and Genomics, National Academy of Science of Ukraine Kyiv, Ukraine*

Global climate changes on our planet are becoming increasingly tangible. Every single degree in global temperature growth induces a decrease in global yields of major crops by 3-8%. Drought causes even more significant losses in crop productivity. Namely, a 40% decrease in the water supply compared to the optimal level causes a 20-40% drop in the grain crop yields [1]. At the same time, it is predicted that by 2050, the freshwater demand in agriculture may double, while its availability may decrease due to climate change by 50% [2]. A separate aggravating challenge is the increased impact of xenobiotics, particularly heavy metals, on plants [3]. Therefore, resistance to these stresses has become central in maintaining yields and product quality.

Another problem triggered by climate change is the penetration of invasive species of pathogens into agrophytocenoses, and their rapid spread, as well as an increase in the negative impact of biotic factors already present in agroecosystems [4, 5].

These challenges and ways to solve them were discussed at the First International Scientific Conference "Plant Stress and Adaptation", organized in February 2021 by the V.V. Dokuchaev Kharkiv National Agrarian University (Kharkiv, Ukraine) with the support of the All-Ukrainian Association of Plant Biologists and the Ukrainian Society of Plant Physiologists. More than 150 research outcomes from 15 countries were presented at the conference. The most interesting and relevant reports were selected for publication in a special issue of The Open Agriculture Journal entitled "Plant Adaptation to Changing Environment and its Enhancement". These articles were focused on two main approaches for improving plant resistance: (1) a physiological one, based on the induction of resistance by exogenous effects of environmentally friendly signaling molecules, phytohormones, and other physiologically active substances, and (2) a genetic approach, aimed at the search for and use of abiotic and biotic stress resistance donors.

Most living organisms react to various stress factors by activating their signaling systems, followed by the transfer of information about adverse effects to the genetic apparatus [6 - 9]. Such reaction facilitates the functioning of the defense mechanisms, mostly related to an antioxidant system [10, 11], stress protein synthesis [8], osmolyte accumulation [12], and structural changes in the cytoskeleton [13]. On the whole, the topics of stress signaling and formation of adaptive responses, as well as the identification of genes that determine plant resistance to stress factors of various nature, have become the key topics in the current special issue.

This edition is started with a review of the mechanisms gasotransmitters, *i.e.* signaling gaseous molecules (NO, CO, H_2S, *etc.*), action plants, thus protecting them from stress. The prospects and ways of the practical application of gasotransmitters' donors in crop production have also been assessed. The review has been prepared by a team of authors from the V.V. Dokuchaev Kharkiv National Agrarian University and the Institute of Food Biotechnology and Genomics at the National Academy of Sciences of Ukraine. The authors, in particular, emphasized the ability of the gasotransmitters to induce post-translational modifications of proteins in plants and functionally interact with each other and with other signaling mediators [14]. These effects are important for stimulating by gasotransmitters of plant adaptations to extreme temperatures, drought, salinity, UV-B and other factors.

In another review, prepared by the Department of Membranology and Phytochemistry at the M.G. Kholodny Institute of Botany at the National Academy of Sciences of Ukraine, the role of chloroplast respiration in plant adaptation to stress factors has been analyzed. This type of respiration acts as one of the alternative pathways of electron transfer in chloroplasts which reduces the likelihood of oxidative damage

* Address correspondence to this author at the Dokuchaev Kharkiv National Agrarian University Kharkiv, Ukraine and Yuriev Plant Production Institute, National Academy of Agrarian Sciences of Ukraine Kharkiv, Ukraine;
E-mail: plant_biology@ukr.net

DOI: 10.2174/18743315-v16-e2208251, 2022, *16*, (Suppl-1, M1) e187433152208251

in plants under stress conditions and maintains ATP levels in the dark [15].

A number of original articles have presented new research into the mechanisms of plant resistance to abiotic stress factors, as well as innovative, practical methods for inducing resistance. Namely, new data have been presented on the role of metabolomic rearrangements (changes in the content of a number of secondary and primary metabolites) in the adaptation of cereals to high and low temperatures [16]. The special role of ascorbate in the regulation of redox homeostasis of tobacco plants under the action of toxic doses of cadmium has been shown in [17]. The growth-stimulating effect of silver nanoparticles synthesized using "green" technologies on *Betula pendula* has also been demonstrated [18], which allows us to consider them as a fundamentally new group of environmentally friendly regulators of plant growth and resistance.

A series of articles have been devoted to the development of new approaches to enhancing plant resistance to diseases. In particular, Kabashnikova *et al*. [19] article assesses the changes in chloroplast activity as a criterion for controlling plant immunity to fungal diseases. The reported data indicate that the state of chloroplasts in the tissues of barley leaves differs at different stages of development, and the response to fungal contamination differs primarily by the activity of PS II, the total content of ROS and polyphenols. The authors believe that these differences may be due to the interaction of signals of different origins, including the contribution of plastids associated with photosynthetic function and also, probably, hormonal signals.

Manzhalesava *et al*. [20] reviewed the results of the induction of plant resistance to fungal diseases using new brassinosteroid phytohormone derivatives – their conjugates with succinic acid. It has been shown that succinic acid enhances the protective effect of brassinosteroids on plants against fungal infection (*Helminthosporium teres*) when used as conjugates and in mechanical mixtures. The effect is the result of the combined cell-stimulating and fungistatic action of succinic acid and brassinosteroids and can be used to increase the resistance and productivity of spring barley plants.

Motsnyi *et al*. [21] assessed the phenotypic diversity of new introgressive wheat lines in terms of resistance to common diseases and drought. As a result of crosses and backcrosses of various primary sources of alien traits with modern wheat varieties, the authors obtained breeding introgressive lines with alien genetic complexes of disease resistance and high protein content. In particular, high long-term resistance to stem rust was noted mainly in derivatives of the H74/90-245 wheat line.

Radchenko *et al*. [22] studied the possibility of using DNA markers to identify genes of resistance of cereals to fungal diseases. Using the codominant marker *cssfr5*, based on detecting a polymorphic state of one of the exons of the *Lr34/Yr18/Sr57/Pm38/Bdv1* gene, the Lr34(+) allele, conferring resistance to leaf rust, was found in 25% of the studied varieties. The matching results obtained with *cssfr5* and *csLV34* markers was 84.5%. The data obtained can be used in breeding programs to create breeding lines and new varieties resistant to leaf rust.

The review and original articles presented in the special issue will be of interest to physiologists, biochemists and molecular biologists dealing with plant resistance to stress, as well as to specialists in innovative developments in the field of plant growing.

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