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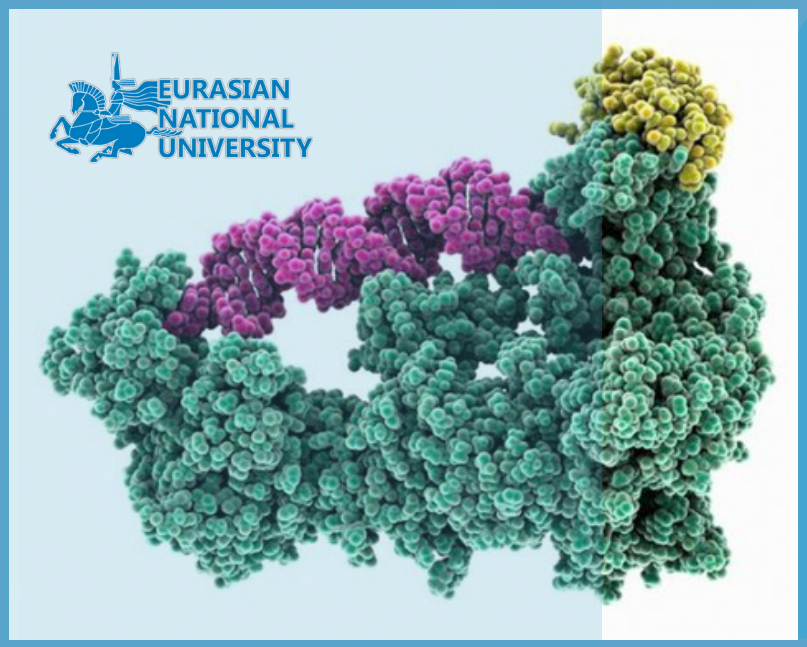

Л.Н. ГУМИЛЕВ АТЫНДАҒЫ
ЕУРАЗИЯ ҰЛТТЫҚ УНИВЕРСИТЕТІ

ЕВРАЗИЙСКИЙ НАЦИОНАЛЬНЫЙ
УНИВЕРСИТЕТ ИМЕНИ
Л.Н. ГУМИЛЕВА

"ОМАРОВ ОҚУЛАРЫ: XXI ҒАСЫРДЫҢ БИОЛОГИЯ ЖӘНЕ БИОТЕХНОЛОГИЯСЫ" АТТЫ ХАЛЫҚАРАЛЫҚ ҒЫЛЫМИ ФОРУМНЫҢ БАЯНДАМАЛАР ЖИНАҒЫ

СБОРНИК МАТЕРИАЛОВ МЕЖДУНАРОДНОГО НАУЧНОГО ФОРУМА "ОМАРОВСКИЕ ЧТЕНИЯ: БИОЛОГИЯ И БИОТЕХНОЛОГИЯ XXI ВЕКА"

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Жинақ «Омаров оқулары: XXI ғасыр биология және биотехнологиясы» атты халықаралық ғылыми форумына қатысушылардың баяндамаларымен құрастырылған. Бұл басылымда биология, биотехнология, молекулалық биология және генетиканың маңызды мәселелері қарастырылған. Жинақ ғылыми қызметкерлерге, PhD докторанттарға, магистранттарға, сәйкес мамандықтағы студенттерге арналған.

Сборник составлен по материалам, представленным участниками международного научного форума «Омаровские чтения: Биология и биотехнология XXI века». Издание освещает актуальные вопросы биологии, биотехнологии, молекулярной биологии и генетики. Сборник рассчитан на научных работников, PhD докторантов, магистрантов, студентов соответствующих специальностей.

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биоразнообразия и устойчивости экосистем. Понимание механизмов адаптации растений к стрессовым условиям помогает нам прогнозировать реакции растительных сообществ на изменения в окружающей среде, такие как изменения климата и антропогенное воздействие.

В заключение, исследования антиоксидантной устойчивости растений играют важную роль в науке и практике сельского хозяйства и экологии. Продолжение этой работы будет способствовать созданию более устойчивых и продуктивных сельскохозяйственных систем и способствовать сохранению природных экосистем в условиях изменяющегося мира.

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Cross tolerance mechanism of heat/cold shock vital for plant to cope with abiotic stress

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ABSTRACT

Global changes of environment changes such as temperature increase, drought, salinity, heavy metals and chilling deadly affected to plants. Growth, development and reproductive stages of plants disrupted by damages of stressors. As a first harbingers of stress condition producing and accumulation of ROS happens in the cell. Naturally, accumulation of ROS is toxic to plant cells, and lead to changes such as protein degradation, lipid peroxidation and breaks of DNA, Hormonal dis-balance and other changes happened after stress treatment. However, Cross tolerance mechanism serves as defensive strategy in plants during the stress condition affected again. Obviously, accumulation of ROS, RCS, RNS have lethal consequences, however, priming by heat/cold shock ameliorated crop's physiological markers of plants. Unfortunately, the molecular mechanism of Cross tolerance does not study deeply. Future perspectives cross tolerance and priming by short term stress will be useful method to save crop productivity under temperature condition.

INTRODUCTION

Abiotic stress and biotic stress are deadly affected factors to all the organism, including plants, and recent decade studying the molecular mechanisms of plants in response to stress condition is in priority. Obviously, under stress condition plants justle for life, and activated many mechanism, activation of genes, enzyme activities, HSP protein and other metabolites which ameliorated plant's defense. Moreover, synchronic action of all these mechanisms tightly linked each other, and regulated to high precision. Thus, through defensive mechanism in plants will be more tolerable to other stress, and this phenomenon known us as a cross tolerance. Cross tolerance has developed during the long time across the evolution, and it improves to plants fast adaptation to environmental changes. Consequently, strong immune system of plants has established because of cross tolerance mechanism [1,2]. Cross talk provides with flexible signaling network and also maintained energy saving, thus ameliorated defense against to the infections. As a familiar to us, phytohormones are critically important mediator of plants in fighting stress [3]. One of the key player of hormonal cross tolerance mechanism is brassinosteroids, which ensures antioxidant defense in response to excess amount of hydrogen peroxide. Brassinosteroid's genes expression occur in the cell as a result of signaling cascade mediated by the cell surface receptor kinase brassinosteroid insensitive 1 (BRI1). The overexpression of the stress responsive genes, production of metabolites, PTI and PCD showed the direct intervention of brassinosteroids [4,5]. Furthermore, cross tolerance mechanism of plants begin with accumulation of Reactive oxygen species such as superoxide ($O2^{-}$) and hydrogen peroxide (H2O2), consequently they triggered the thiol-modulated redox- and nitric oxide-mediated (NO) signalling pathways. Additionally, superfluous amount of pollutants in air leads to generation of ROS in apoplast, which cause of signaling network activation. Activation of signaling cascades against to stressor, mediated by hormonal system such as ethylene (ET), salicylic acid (SA), abscisic acid (ABA), auxin and jasmonic acid (JA) [6,7,8]. Moreover, Reactive carbonyl species (RCS), reactive nitric oxide (RNS) and reactive oxygen species (ROS) are cause heat or cold priming cross tolerance of plants, the importance of these molecules lay in the role which activated stress responsive genes, heat shock proteins (HSP), plant hormonal system, ROS scavenging enzymes, enhancing metabolism, osmolytes and redox signaling pathways. Stress affects sensed by receptors located on cell wall and it was a cause of activation of reactions by using secondary metabolites.

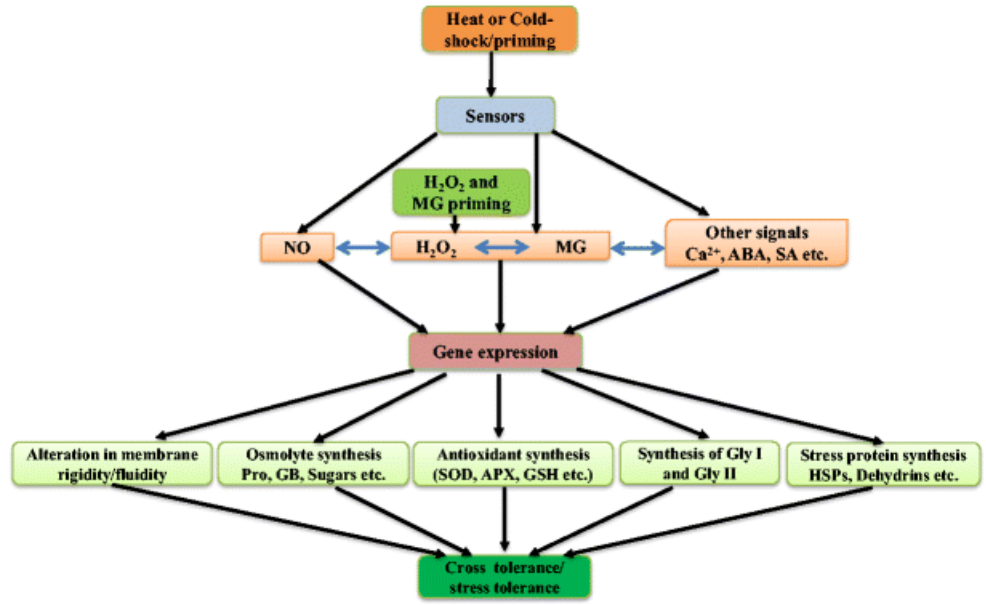

Figure 1 Heat/cold priming cross tolerance mechanism. Figure adapted from Hossain, M. A (et.al) [22].

Calcium ion, RNS, ROS, RCS and kinases are vital molecules which helps to plant tolerance against to heat, cold stress. The main change which is capable regulate stress tolerance of plants under temperature stress is a rigidity/fluidity of membrane [9,10,11,12].

Temperature stress affected negatively to plants, through delaying their growth and development, reducing photosynthetic abilities, increasing water loss and at the result it can lead to cell death. Interestingly, not extremal temperature and short term high temperature stress improved tolerance of plants to not only high temperature stress. Also, heat priming useful for cross tolerance of plant, agricultural usage of this method critically, but the mechanism of these methods tightly linked with biochemical, physiological and molecular changes, which are not known us [13,14].

Naturally, freezing or chilling cold stress lead to worsening of plant's physiological condition, but plants which primed by cold temperature illustrated the improved tolerance to other stress. Additionally, cold priming lead to the activation of cold regulated proteins (COR), accumulation of antioxidants, sucrose, enhancing of enzymes activities participating to Calvin cycle [10,12,15].

Eventually, heat shock or cold shock provide cross- tolerance to stress in plants, temperature treatment helps to plants to be more tolerable to other stresses.

The mechanisms which lay in the basis of the cross tolerance of heat/ cold priming, tightly bounded with ROS accumulation. The production of ROS highly regulated with enzymatic or non-enzymatic redox networks. Additionally, antioxidant defense participated to control the ROS concentration in the cell, antioxidant scavenger basically located in apoplast, cytosol and including chloroplasts, mitochondria and peroxysomes. Experiment which proven by maize showed that the heat shock for 4h affected to accumulation of hydrogen peroxide (H2O2), after several times those maize was more tolerable to drought stress, heat and salinity stress. These study demonstrated the importance of H2O2 as a signaling molecules in cross stress tolerance in *Zea mays* [17,18]. As another study reported, the cold, high temperature and paraquat primed tomato plants showed a higher tolerance level to chilling, drought and photo-oxidative stress tolerances, as a result of accumulation of hydrogen peroxide in apoplast [19]. Accumulation of hydrogen peroxide led to activation of ROS scavenging enzymes such as catalase (CAT), superoxide dismutase (SOD), ascorbate peroxidase (APX) and glutathione reductase (GR), consequently, take place a mitogen-activated protein kinases (MAPKs)

activation. Also, this report shows the cross tolerance interaction of hydrogen peroxide and MAPK kinase [19].

methylglyoxal (MG) is reactive carbonyl specie which produced by as a byproduct of glycolysis and accumulation of Methylglyoxal (MG) is toxic to plants cell. MG affects to cell deadly, by disrupting molecules such as protein glycation and glycation accumulation. Similarly, effects such as mutation, DNA strain breaks, exchange of sister chromatids, were detected in organism when RCS concentration higher than usual. In plans producing of MG happens through several processes including enzymatic, non-enzymatic pathway, photosynthesis and respiration. Despite the side effects of MG, methylglyoxal serves as signaling molecule, which lead to changes of stomatal conductance, cross talk interaction with ROS, Ca ions and Abcisic acid level. Correspondingly, RCS molecules capable to act as signaling to cross tolerance like ROS molecules. Additionally, the exogenous treatment by MG can affect positively, by improving germination rate, growth of wheat under salt stress [20,21].As a ROS molecules RCS are serve as a signaling molecules which tightly bounded with cross tolerance mechanism of plants, also exogenous treatment with MG helps to crops' growth [22].

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Улучшение геномного редактирования с помощью анти-CRISPR белков

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Короткие палиндромные повторы, расположенные регулярными группами (CRISPR) служат важнейшим компонентом адаптивного иммунитета у значительной части бактерий и архей, обеспечивая защиту от вторгающихся фагов и мобильных генетических элементов [1]. Взаимодействие между CRISPR-РНК (crRNAs) и CRISPR-ассоциированными белками (Cas) позволяет обнаруживать чужеродый генетический материал с последующим его уничтожением, защищая тем самым организм хозяина от инфекции. Однако адаптивность фагов привела к появлению механизмов уклонения или преодоления иммунитета к CRISPR, включая мутацию последовательностей-мишеней и выработку анти-CRISPR белков (Acr) [2].

Появление технологии редактирования генома CRISPR, в частности основанной на системе *Streptococcus pyogenes* (*Spy*) Cas9, произвело революцию в биомедицинских