

How Plant Cope Environmental Stresses: An Overview

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Abstract

Rapid growth in human population, ultimately affect our environment in many ways. For example, increase in food demands results in deforestation, and loss of soil fertility. Invasion of new plant species also disturb ecological balance and biodiversity. Plant applied various physiological mechanisms to sustain itself in changed environmental condition. Most of the local cultivars hardly survive in changed environmental conditions because nature takes millions of year for genetic modification. Rise of new cultivars, by gene manipulation may overcome these stress related issues. But what about wild plant varieties is a matter of discussion. In this review we discuss that how plant cope these stresses. How many types of stresses and what are the mechanisms they applied for tolerance? Although it is difficult to cover all physiological aspects governing in plant during, such condition. This review outlines the recent research findings and discusses the challenges, with particular emphasis on plant ability to cope with stress.

Keywords: *Soil fertility; Abiotic stress; Gene manipulation; Biotechnology*

Introduction

Green plants are the smartest creation of Mother Nature. Our planet is liveable for aerobic organism because respiratory waste released by green photosynthetic organism. Unfortunately, green photosynthetic plants are now facing a threat due to anthropogenic activities [1-8]. How plant sustains them in this catastrophic environment, and what are mechanism they applied, is object for review article. Fortunately, lots of research work was done earlier by our scientific community on plant physiology [9-15]. The whole review article is divided in 5 heading with subheadings.

It's not possible for us to cover all topics related to subject line but we tried here to touch every aspect relevant to this.

Abiotic and Biotic Stresses

Plant has intimate relation to their environment especially with abiotic components [16,17]. Plant adopted unique strategies to cope extreme environmental changes [18-21]. Priming is one of the mechanisms they employed to enhance their defence mechanism. It enhances the resistance in plant against environmental stresses [22-27]. Among abiotic stresses cold stress is adversely affecting the plant productivity especially in tropical and subtropical climate [28-31]. Plants growing in temperate areas are less sensitive to cold stress in compare to tropical vegetation. Cold tolerant and cold sensitive species are differing

in response to low temperature because of genetic variability. If we successfully disclose the molecular mechanism, that might be utilized for cultivar improvement through biotechnology [32-40].

Besides low temperature, salinity and drought are other abiotic factors which adversely affect the crop yield in subtropical deserts [41-46]. Interestingly, some halophilic bacteria and Archaea showing promising hands towards salt tolerance. These microorganisms tolerate high salt concentration either by storing salt in cytoplasm or by accumulation of uncharged organic compounds to maintain an osmotic potential with surroundings [47-51]. These nature borne techniques can be exploited for development of salt tolerant crop varieties.

Because of sessile nature to environmental stresses, plants are severely affected by environmental stresses such as extreme temperature, salinity, drought, waterlogging, and heavy metal [52-57]. Drought is a common major issue in arid and semiarid areas. Under drought condition, plants generate active oxygen species which can induce oxidative stress. Active Oxygen Species (AOS) can destruct the cell membrane system, and cause serious metabolic disturbances. Plants have limited ability to destroying active oxygen species. In adverse condition, this balance is shift towards more AOS accumulation [58-64]. Due to these consequences, plants express some morphological symptoms such as reduction in height, leaf length, loss in fresh and dry weight and biomass yield. Some desert plants surpass drought stresses with their unique feature to survive under high salinity and low water condition. Tapping the advancement of genetic manipulation, new cultivars with drought resistance can be grown in arid areas.

Improve Stress Tolerance

Genetic engineering and transgenic plants

Plant response to different environmental stresses is a crucial to their productivity. Both biotic and abiotic components affect plant growth significantly but abiotic stress play major role [65-71]. Plants having a set of genes that can be divided in to two major classes, gene encoding functional proteins and genes encoding regulatory proteins. Due to practical limitations scientist are choosing functionally related genes for genetic manipulation [72-78]. However, thousands of genes related to stress tolerance were identified and few of them are found suitable to impart gene for stress tolerance in plants. Therefore, transcription factor operating in early stage of stress is a potential tool for genetic engineering [79-81]. Among the various transcription factors, homeobox genes were well expressed phenotypically and identified as most appropriate gene for abiotic stress response. Another example is APETALA2/ethylene response element-binding protein (AP2/EREBP) transcription factor family. It's reported from Arabidopsis plant. AP2 family genes not only enhance stress tolerance in Arabidopsis plant but, also in crop plants. Therefore transgenic plants with AP2 family genes can easily survive in harsh environmental menaces.

Osmotic potential regulator: osmoprotectants

It was noticed that few plants under adverse environmental condition adopted new pathway i.e. osmoprotectant pathway. These maintain osmotic potential of cell through stabilizing membranes and proteins during stress condition. Osmoprotectants /compatible solutes primarily include glycine, proline, ectoine, betaines, trehalose, and polyols [82-87]. Thus, we required a more elaborate approach to look past the current scenario.

Epigenetic modifications in plants

Crop breeders are now applying nongenetic or epigenetic determinants that could modify gene expression heritably and reversibly (without changing the gene sequence). These include histone modifications, DNA methylation, nucleosome positioning, and small (sm) RNAs [88-91]. They modify the properties of chromatin and change gene transcriptional states.

Nitric oxide emerges as a tool to resolve stress related physiological disorders in plants. Nitric oxide works as signalling agent and involve in detoxification of reactive oxygen [92,93]. We required more interrogation on various pathways where nitric oxide plays a crucial role.

Competitiveness, Coexistence and stress tolerance are few characters which can be observed among various weed species. Availability of the sophisticated molecular tools provides us an opportunity to transfer genetic material from weeds to crop plant for stress resistance.

Arbuscular Mycorrhiza: a warrior against abiotic stress

A group of fungi colonizes in plant roots known as mycorrhiza is emerges as new tools in stress tolerance. These mucorrhiza form extensive network of hyphae and secretes some biochemical like glomalin. These mechanisms include enhanced growth by prevention of nutrient deficiency and ion toxicity, osmotic adjustment in water stress condition, enhancing the activities of antioxidants and prevention of oxidative damage, restriction of entry of toxic ions and immobilization of heavy metals in soil or plant roots [94,95].

Biofertilizers: an eco-friendly approach towards abiotic stress

Generally chemical fertilizers are expensive and cause eutrophication, ion toxicity, reduce organic matter and soil borne microorganism. In compare to fertilizers, biofertilizer are inexpensive and enhance soil fertility without harming natural soil ecosystem [96,97]. Biofertilizers are rich source of organic nutrient and provide natural environment to beneficial microorganism. These microorganisms secrete antibiotics which are effective against plant pathogen.

Biotic Stress

Like abiotic stresses, biotic stress also plays a vital role in plant growth and development. Continuous plant-pathogen interaction is generated a complex immune system that consists of preformed barriers and induced responses. In last decades, plant biologist collected valuable information related to plant-pathogen interaction, which can be applied in crop improvement by genetic manipulation [98-101]. Plant breeding has helped in isolation of stress tolerant plant species. These species might be helpful in development of resistant varieties.

Global Meetings

Climate change is causing threat to our habitable environment and food security. Plant biologists all over the world are looking for proper solution to diminish the effect of climate change. Omicsconerence.com will organize several conferences worldwide to provide a platform to scientific community to combat this problem. 21st Global Food Engineering Conference is one of them where they will discuss the cutting age technology in field of food engineering. 7th European Food Safety & Standards Conference is another one in this list, where we will focus on role of biotech in crop improvement programme and designing of stress tolerant crop varieties. 8th World Congress on Agriculture & Horticulture will be organized around the theme "Growing Aspects of Agriculture". For sustainable growth it's essential for us to include developing countries in

global effort. So they are organizing one such conference meeting in Thailand i.e. 2nd International Conference on Plant Science & Physiology. Some others related conferences are 7th International Conference on Global Food Safety; 6th International Conference on Food Safety & Regulatory Measures.

Societies

Some prominent societies are working on this to find suitable solution, like Nepal Herbs and Herbal Products Association (NEHHPA) is an association of herbal producers. Another one European Biotechnology Thematic Network Association (EBTNA), which is an association of biotechnology professionals. Open access journal also play a major role in dissemination of latest research in scientific community. Journal of Plant Physiology & Pathology and VEGETOS: An International Journal of Plant Research is publishing quality research article in field of plant physiology. Journal of Fertilizers & Pesticides is enhancing our information for sustainable use of fertilizer.

Conclusions

Climate change are not only influencing the human but also affecting the plant in the form of abiotic and biotic stresses. It is challenge in front of plant biologist to find useful techniques and tools that can help the plant to survive in the stressful condition. But still some question to be answered. How some tolerant plant varieties cope these stresses? What are the mechanism they applied to overcome adverse condition? We are successfully applying genetically modified crop varieties as cultivars. The development of GM crops will help in generating higher yields against changed environmental condition.

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