Xournals

Academic Journal of Botanical Sciences

ISSN UA | Volume 01 | Issue 01 | June-2018

Effects of Abiotic and Biotic Stress on the Plant

Kalpesh sardhara[1] and Kavit Mehta[2]

Available online at: www.xournals.com

Received 27th January 2018 | Revised 30th April 2018 | Accepted 22nd May 2018

Abstract:

Environment affects the plants in the different forms of stresses due to which the growth and development of plants are affected. These stresses may be abiotic such as drought, heat stress, and soil salinity or biotic such as pathogen, bacteria and viruses. Some plants have the ability to fight with these stresses by their morphological, physiological and biochemical activities. But all plants do not control the stresses and affected by these stresses and died because of the changes the activities of plant like reduction in the photosynthesis pigments, reduction in the transportation of water to plant parts etc. This review study shows the response of plants toward the different types of stresses by their activities and new technologies (genetic engineering), use of nutrient in the production of plants that can reduce the stress form the plants.

Keywords: *Abiotic, Biotic, Stress, Nutrient, Genetic Engineering*

Authors:

1. *Mehsana Urban Institute of Sciences, Ganpat University, Ganpat vidyanagar, Gujarat, INDIA 384012,*
2. *Assistant Professor, Mehsana Urban Institute of Sciences, Ganpat University, Ganpat vidyanagar, Gujarat, INDIA 384012,*

Introduction

An altered physiological condition due to the alteration in an equilibrium is known as stress. Stress produces physical and chemical changes that is called as strain as when an established condition forces a system to leave its thermodynamic optimal state. Plant growth and other activities (Productivity) are affected by many stresses in nature by changes in their morphological, physiological, biochemical and molecular series. So, plant stress is divided into two category. Biotic and Abiotic Stress.

Biotic Stress

Numerous biotic stresses and adverse environmental conditions are faced by the plants in the term of their morphological, biochemical, and molecular mechanisms. Biotic stresses in plant are the damage which are occur due to living organisms such as pests, parasites, bacteria, fungi, nematodes, insects, viruses etc. These living organisms are responsible for the plant diseases. According to Wang et al (2013), biotic stress can cause a 28.2% yield loss of wheat, 37.4% loss of rice, 31.2% loss of maize, 40.3% loss of potatoes, 26.3% loss of soybeans and 28.8% loss of cotton. Fungi factor is a biotic stress factor that cause diseases the plant and crop more rather other factors. Besides fungi factor, other microorganisms can cause plant wilt, leaf spots, root rot and seed damage.

Abiotic Stress

Any environmental condition rather than the action of other organism that reduce the growth, survival and fruitfulness of plants is called as abiotic stress. There are different types of abiotic stress such as draught, high soil salinity, floods, extreme temperatures (too high or too low), reduced light level or excess of UV radiation, acidic or alkaline soils, soils poor in nutrients, etc. Most of the crops and plants are sensitive to abiotic stress. According to Wang et al (2013), Yield losses from abiotic stress were estimated at 65.8% for maize, 82.1% for wheat, and 69.3% for soybeans and 54.1% for potatoes.

Effect of Water Stress on Plant

When the water supply becomes limited to the roots or rate of transpiration become intense, plant is experienced by the water stress. Water deficit (drought and high soil salinity) is a prime cause of water stress as due to high soil salinity, flood, or low soil temperature, plants cannot uptakes the water that exist in the soil solution is known as physiological drought.

Firstly, the effect of water deficit are not understood at biochemical and molecular levels but its understanding is very crucial. Water stress is tolerated by all plants but its degree varies from species to species. In case of drought, due to dehydration, many plant are died. Water potential of plant cell and turgor is reduced in the plants due to water stress that elevate the solute's concentration in cytosol and extracellular matrices. The plant water relations is affected by the reduction of water content, turgor and total water due to drought. Stomatal closure, limits gaseous exchange, reduction in the transpiration and carbon assimilation (Photosynthesis) arrest rate are the seen due to the effect of drought.

Drought and Oxidative Condition in Plants

Oxidative stress also comes under abiotic stress due to high temperature, salinity, draught stress. It is a serious secondary effect on cells. The formation of reactive oxygen species (ROSs) like oxides, water and hydroxides are due to effect of oxidative stress due to which membranes and macromolecules of plant are damaged and affect the metabolism of cells.

An imbalance is created between light capture and its utilization due to effect of drought. This imbalance prevents the photosynthesis in leaves. Reactive Oxygen Species (ROSs) is generated by the degeneracy of excessive light energy in photosynthesis apparatus. ROS gives the result in the form of Denaturation of functional and structural macromolecules, DNA nicking, amino acids, protein and photosynthetic pigments oxidation, and lipid peroxidation. Then, against the ROS, some responses is activated by cells such as an increase in the expression of genes for antioxidant functions and production of stress proteins, up-regulation of anti-oxidants systems, including antioxidant enzymes and accumulation of compatible solutes.

Effect of Salt Stress on Plant

Nowadays, a world has a large population due to which the production of 70% more food crop is a major challenge. In this case, salinity is a major stress that limits the increment in the demand of food crops. Salt stress affects more than 20% cultivated land worldwide and the amount of the salt stress is increasing day by day. On the basis of adaptive evolution, plants are categorized into two parts:

Halophytes: Those plants that can withstand on the salt stress

Glycophytes: These are those plants that cannot be withstand on the salt stress and died.

In the world, the majority of glycophytes are high due to which salinity is the most dangerous environmental stress. Various physiological and metabolic processes are changed because of the salinity. These changes depend upon the severity and duration of the stress due

to which the crop production is inhibited. In the initial stage of salinity stress, water loss from the leaves, the decrement in the water absorption capacity of root systems are occurred due to osmotic stress. This osmotic stress disrupts the cell ions homeostasis through the inhibition of up taking essential elements such as potassium, calcium and nitrogen trioxide and high accumulation of sodium and chlorine. The accumulation of sodium, chlorine and boron in the tissue of transpiring leaves create a high ion toxicity. The high salt is accumulated in soil and plants is considered as hyperosmotic stress.

Salinity also affects the photosynthesis reaction as it decrease the carbon dioxide availability due to which the diffusion in the plants is limited by which the contents of photosynthesis pigments are reduced. Total photosynthetic capacity of the plant is decreased by the salinity by which the decrement in the leaf growth and limiting its ability to grow.

Combination of Different Stress

Different stress combination are arise due to the climate change and the impact of them on plants. Stresses are grouped into three categories that are based on the number of interacting factors: single, multiple individual and combined stresses.

Single Stress: Plant growth and development are affected by only one stress factor.

Multiple Individual Stress: The occurring of two or more stresses at different intervals and they do not overlap to each other.

Combined Stress: The occurrence of two or more stresses at same time and overlap to each other. For example, in summer, the co-occurrence of draught and heat stresses is a combined abiotic stress. It is most evident stress combination. While combined biotic stress is the attack of bacterial and fungal pathogen at a same interval.

Disease triangle is formed due to the impact of environmental factors on the plant diseases which has been made an important attention for the plant pathologist. The effect on plants due to different types of stress interactions depends upon the nature, severity and duration of the stresses. The interaction is not occurred only on the plant interface, also at and outside the plant interface in the abiotic- abiotic and abiotic-biotic stress interactions.

Role of Potassium and Silicon in the Reduction of Stress:

The deficiency of potassium in the plants has a more chances of the infection than the sufficient or adequate supply of potassium. For example; the great borer infestation on the rice due to no supply of potassium but it decrease as the concentration of potassium is increased. In some cases, potassium has an effective impact but sometimes, it gives no effect or even an adverse effect. Plants with the sufficient potassium have high molecular weight compounds such as proteins, starches and cellulose. on the another side, the concentration of low- molecular weight compounds such as soluble sugars organic acids, amino acids and amides are decreased. For the development of infections and insect infestations, low molecular weight compounds play an important role. Therefore, plants leaf are less vulnerable to disease and pest attacks in potassium sufficient plants.

The limits of potassium in the plants are due to the drought stress as both the rates of potassium diffusion in soil from roots and the root growth are restricted. Therefore, a close relationship is seen between the potassium nutritional status and plant drought stress. The potassium plays a role in physiological and molecular mechanisms of plant drought resistance.

Silicon is also a most abundant element in soil. Silicon occurs in the soil solution in the form of monosilicic acid at concentration 0.1 to 0.6 mM. After absorption, it accumulates on various tissues's epidermis as a polymer of hydrated amorphous silica. Silicon suppresses or destroys the insect pests and non-insect pest such as stem borer, brown plant hopper, rice green leafhopper, and white backed plant hoppera and leaf spider and mites. In culture solution, the increment in the concentration of silicon in cucumber that increase the buds, helps in reducing the powdery mildew disease. Physical stresses such as radiation (It injured plants), low and high temperature, wind, drought and waterlogging and so on can also be controlled by silicon.

Review of Literature

Cramer *et al.* (2011) observed the responses of plants against the abiotic stress. There are many factors such as physical. Morphological and molecular limitations that inhibit the plants to respond against the stress. The responses of plant to abiotic stress are dynamic and complex. The genes play a vital role in the improvement of stress tolerance of crops.

Lisar *et al.* (2012) discussed that drought (water deficit) is a severe due to the long effect of it on plants. Some plants are capable to develop their innate mechanism to fight with water stress but no all plants. However in the result, reduce photosynthesis.

The plant adopted the conservative water management scheme to help them to reduce the loss of water and

increase the availability of water uptake by considering the maxim utilization of physiologically available water.

Wang *et al.* (2013) concluded by the effect of biotic and abiotic stresses, the quantity and quality of the crop production is decreasing day by day. In the same way, intensive fertilization is necessary for the production of food as more demand. Therefore, the excess of nitrogen fertilization and deficiency in the potassium are the causes of reduction the crop quality and quantity. There is need of significant increase in the potassium fertilization because potassium is an essential plant nutrient.

Jaleel *et al.* (2014) proposed that ramified root system may be used in the drought tolerance. High biomass production also an important source as it extract more water from soil and transport to the leaves and other parts of plant for the photosynthesis reaction. Photosynthesis pigments class 'carotenoids' help in tolerating the drought by multiple roles such as light harvesting, protection from oxidative damage caused by drought. Hence, carotenoids are important pigment class for the stress tolerance.

Shrivastava and Kumar (2014) Stated that abiotic stress conditions give an adverse effect on the agriculture production. In this case, microorganism of plants play an important role in the decrement of abiotic stress. Genetic engineering and plant breeding is also important for the stress tolerance but it is long process and expensive while microbial phenomenon is more cost effective and environmental friendly for the tolerance of stress.

Gupta and Huang (2014) studied that complete profile of genes, proteins, and metabolites development are responsible for the different types of mechanisms of the salinity tolerance in different plant species. But there is lack of knowledge of genomic, transcriptomic, proteomic, and metabolomics studies. Therefore, in future study should be conducted on intercellular and intracellular molecular interaction with salinity stress response. In the development of salinity tolerant plants, genetic engineering has been proved as an efficient approach.

Pandey *et al.* (2017) Combination of different abiotic and biotic stresses and the interaction between them have an impact on plants either in positive way or in negative ways. Therefore, it is necessary to study the interaction of these stresses to understand the net impact of stresses on plants. The analysis of performance of superior or tolerant genotypes can done in better way by the understanding of plant response against the combined drought and pathogen stress. Hence, the development of combined stress tolerant crop with well performance can be lead by the integrative efforts from crop modeling experts, agronomists, field pathologists, breeders, physiologists, and molecular biologists.

Machado and Serralheiro (2017) proposed that salt stress tolerance can be done by the fertilization and irrigation management strategies. Fertilization increases the nutrient (Silicon, humic acid) use efficiency by which salt tolerance of vegetable crops can be enhanced. Biofertilizers are another sources that can be used to reduce the soil salinization and increase the salt tolerance of vegetable crops.

Conclusion

Stress either biotic or abiotic are the major factors that affect the plant growth and development. This review study shows that drought and salt stresses change the plant activity as oxidative stress produce by the drought condition disturbs the photosynthesis reaction by capturing more light. The salt stress inhibits the transportation of water to the all part of plants due to which the essential nutrient are unable to reach to plant parts. Some researcher worked on the plant physiology and stated that the plants also response against the stresses. Potassium and Silicon are the essential nutrients that can be used in reducing the plant stress. Before dealing with the plant stress, there is a need to understand types of effect of abiotic and biotic stresses because stresses and the capability of controlling these stresses vary from species to species of plants.

References:

Cramer, Grant R, *et al.* "Effects of Abiotic Stress on Plants: a Systems Biology Perspective." *BMC Plant Biology*, vol. 11, no. 1, 2011, p. 163.

Gimenez, Estela, *et al.* "Worldwide Research on Plant Defense against Biotic Stresses as Improvement for Sustainable Agriculture." *Sustainability*, vol. 10, no. 2, Feb. 2018, p. 391.

Gupta, Bhaskar, and Bingru Huang. "Mechanism of Salinity Tolerance in Plants: Physiological, Biochemical, and Molecular Characterization." *International Journal of Genomics*, vol. 2014, 2014, pp. 1–18.

Jaleel, Cheruth Abdul, *et al.* "Drought Stress in Plants: A Review on Morphological Characteristics and Pigments Composition." *International Journal of Agriculture & Biology*, vol. 11, no. 1, 2009, pp. 100–105.

Lisar, Seyed Y. S., *et al.* "Water Stress in Plants: Causes, Effects and Responses." *Water Stress*, July 2012.

Ma, Jian Feng. "Role of Silicon in Enhancing the Resistance of Plants to Biotic and Abiotic Stresses." *Soil Science and Plant Nutrition*, vol. 50, no. 1, 2004, pp. 11–18.

Machado, Rui, and Ricardo Serralheiro. "Soil Salinity: Effect on Vegetable Crop Growth. Management Practices to Prevent and Mitigate Soil Salinization." *Horticulturae*, vol. 3, no. 2, Mar. 2017, p. 30.

Onaga, Geoffrey, and Kerstin Wydra. "Advances in Plant Tolerance to Biotic Stresses." *Plant Genomics*, 2016.

Pandey, Prachi, *et al.* "Impact of Combined Abiotic and Biotic Stresses on Plant Growth and Avenues for Crop Improvement by Exploiting Physio-Morphological Traits." *Frontiers in Plant Science*, vol. 8, 2017.

Shrivastava, Pooja, and Rajesh Kumar. "Soil Salinity: A Serious Environmental Issue and Plant Growth Promoting Bacteria as One of the Tools for Its Alleviation." *Saudi Journal of Biological Sciences*, vol. 22, no. 2, 2014, pp. 123–131.

Wang, Min, *et al.* "The Critical Role of Potassium in Plant Stress Response." *International Journal of Molecular Sciences*, vol. 14, no. 4, Feb. 2013, pp. 7370–7390.