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Impact of Abiotic and Biotic Strain on the Plant

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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*

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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 bodily entities such as pests, fungi, bacteria, insects, parasites, nematodes, viruses etc. These living organisms are responsible for the plant diseases. According to Wang et al (2013), biotic strain can cause a 37.4% loss of rice, 28.2% yield loss of wheat, 40.3% loss of potatoes, 28.8% loss of cotton, 31.2% loss of maize and 26.3% loss of soybeans. Fungi factor is a biotic stress factor that cause diseases the plant and crop more rather other factors. Besides fungi factor, other micro-organisms can cause plant wither, root rot, leaf spots, and seed impairment.

Abiotic Stress

Any ecological disorder rather than the action of another organism that lessen the growth, existence and fruitfulness of plants or crops is called as abiotic stress. There are different types of abiotic stress such as high soil salinity, drought, floods, reduced light levels or excess of UV radiations, extreme temperatures (too high or too low), soil poor in nutrients, acidic or alkaline solids, etc. Maximum of the crops and plants are quite sensitive to abiotic strains. According to Wang et al (2013), Crop losses from abiotic stresses were projected at 82.1% for wheat, 65.8% for maize, and 69.3% for soybeans and 54.1% for potatoes.

Consequence of Water Stress on Plants

Whenever the water supply becomes confined 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 result of water shortage are not understood at bio-chemical, and molecular levels but its understanding is very crucial. Water stress is tolerated by all the plants but its degree fluctuates from class to class. In case of drought, caused 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 decrease of water content, total water and turgor due to drought. Stomatal closing, limited gaseous exchange, reduction in the transpiration, and carbon assimilation or Photosynthesis arrest rate are the seen due to the effect of drought.

Famine and Oxidative Conditions in Plants

Oxidative strain also comes under abiotic stress due to high temperature, salinity, draught stress. It is a severe secondary negative impact 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 structural and functional macromolecules, amino acids, DNA nicking, lipid peroxidation, protein and photosynthetic pigments oxidation. Then, against the ROS, some responses are activated by cells like, an upsurge in the genes expression for antioxidant purposes and manufacture of stress proteins, up-regulation of anti-oxidants structures, including antioxidant enzymes and buildup of attuned solutes.

Consequence of Salt Stress on Plant

Nowadays, the world has a large population due to which the manufacture of 70% additional food crop is a major challenge. In this case, salinity is a chief stress that limits the increment in the requirement of food crops. Salt stress affects greater than 20% cultivated land worldwide and the amount of the salt stress is growing day by day. As per the basis of

adaptive advancement, 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 the time duration of the stress due to which the harvest 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 buildup of sodium, boron and chlorine in the tissue of transpiring leaves create a high ion toxicity. The accumulation of high salt in soil as well as the 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. Complete photosynthetic capacity of the plant is lessened by the salinity by which results in the decrement of the leaf growth, thereby limiting its ability to grow.

Combination of Different Stress

Different stress combination arise because of the changes in climate and their effect on the plants. Stresses are grouped into three categories that are based on a varied number of interrelating factors: single stress, multiple individual stress and combined stress.

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 a number of stresses at the same time duration and overlay to each other. For example, in summer, the combined occurrence of drought and excessive heat stresses is a form of combined abiotic stress. It is most evident stress combination. While combined biotic stress is the attack of fungal and bacterial pathogen at a same time interval.

Disease triangle is formed due to the effect of ecological features on the plant infections 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 severity, nature and extent of the stresses. The interaction is not occurred only on the plant interface, also at and exterior plant interface in the abiotic- biotic and abiotic-abiotic 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 satisfactory production of potassium. For instance; the great borer plague 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 a huge molecular weight compounds, such as proteins, starches and cellulose. On the another side, the concentration of less-molecular weight compounds, like soluble sugars organic acids, amino acids and amides are decreased. For an ardent development of infections and insect infestations, low molecular weight compounds play an important role. Therefore, plants leaf are less susceptible to disease and pest outbreaks 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 biological and molecular mechanisms of plant in drought resistance.

Silicon is also the most abundant element in soil. Silicon occurs in the soil substrate as monosilicic acid with a 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 pests such as brown plant hopper, stem borer, white backed plant hopper, rice green leaf hopper, mites and leaf spiders. 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 plant responses against the abiotic stress, on the basis of many factors such as physical, molecular and morphological limitations that inhibit the plants to react against the strain. The reactions of plants to abiotic stresses are dynamic as well as complex. The genes play a pivotal role in the enhancement of strain 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 inborn mechanism to fight with water tension but not 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 quality and quantity of the crop manufacture 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 forbearance. Huge biomass manufacture also an important source as it extracts more water from soil and transport it to the leaves and other parts of plant for the photosynthetic reaction. Photosynthesis pigments class ‘carotenoids’ help in tolerating the drought by multiple roles such as light reaping as well as protection from oxidative damage caused due to 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 display an important part in the decrement of any abiotic stress. Genetic engineering as well as 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 profiling of proteins, genes, and metabolites development are accountable for the various types of mechanisms of the salinity tolerance in various plant species. But there is absence of knowledge of transcriptomic, genomic, metabolomics and proteomic 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) the combination of various biotic and abiotic stresses and the interface 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 conjoint drought and pathogen strain. Hence, the general development of combined strain tolerant crop with well performance can be led by the integrative determinations from agronomists, physiologists, breeders, molecular biologists, crop modeling experts, and field pathologists.

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

Conclusion

Stress either abiotic or biotic are the chief factors, which affect the plant development and growth. 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 biotic and abiotic stresses because stresses ,and the capability of controlling these stresses vary from species to species of plants.

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