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وحماية المستهلك

Subject Review

EFFECT BIOCHEMICAL OF HEAT STRESS ON PLANT

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ABSTRACT

Heat is one of the main environmental stresses that limits the growth, development and production of plants at the global level as a result of the negative effects it causes at different plant levels. Reactive Oxygen Species (ROS), is one of the biochemical effects of heat produced under aerobic conditions inside plant cells, in normal conditions they regulate cell signals and growth and there is a balance between is formed and is destroyed. However, under of various stresses including heat, this balance is disturbed and leads to the occurrence of disorders in the physiological processes of the plant and the destruction of cell components. The use of chemicals such as osmotic protection compounds, plant hormones, signaling molecules, nutrients, in addition to agricultural practices such as the optimal planting date, irrigation water scheduling, and seed priming process have contributed to reducing the harmful effect of heat and increasing the effectiveness of antioxidants in plants to counter the negative effects of ROS in shade of climate change.

Keywords: Climate change, Heat stress, Biochemical effects, Free radicals.

التأثيرات البايوكيميائية للشد الحراري على النبات

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الخلاصة

تعد الحرارة من الشدود البيئية الرئيسية التي تحد من نمو وتطور النباتات وانتاجيتها على المستوى العالمي نتيجة للتأثيرات السلبية التي تحدثها على مستويات النبات المختلفة. انواع الاوكسجين التفاعلية (ROS) احد التأثيرات البايوكيميائية للحرارة تنتج تحت ظروف هوائية داخل خلايا النبات، في الظروف الطبيعية تنظم ايعازات الخلية والنمو وهناك توازن بين ما يتكون وما يهدم منها الا انه وتحت ظروف الشدود المختلفة ومنها الحرارة يتم الاختلال بهذا التوازن فتؤدي لحدوث اضطرابات في العمليات الفسيولوجية للنبات وتدمير لمكونات الخلية. لقد ساهم استعمال المواد الكيمياوية كمركبات الحماية الازموزية، الهرمونات النباتية، جزيئات الايعاز والمغذيات بالاضافة للممارسات الزراعية كموعد الزراعة الامثل وجدولة مياه الري وعملية تنشيط البذور في تقليل التأثير الضار للحرارة وزيادة فعالية مضادات الاكسدة في النبات لمواجهة التأثيرات السلبية لـ ROS في ظل التغير المناخي.

الكلمات المفتاحية: تغيير المناخ، شد الحرارة، التأثيرات البايوكيميائية، الجذور الحرة .

INTRODUCTION

Due to natural or anthropogenic activities, climate change has increased the emission of gases responsible for global warming, and heat has become one of the environmental stresses that have caused a decrease in the growth and productivity of plants in general and crop plants in particular (**Muhammad *et al.*, 2017**). plants differ according to the variety and plant type in their growth temperature, some of them grow optimally between 0-10 Cº, and others prefer growth in moderate temperatures between 10-30 Cº, and there are those that grow between 30-65 Cº or higher (**Źróbek-Sokolnik, 2012**), This difference is caused by the nature of the genetic combination that gives the plant anatomical, morphological and biochemical characteristics that make it grow at this temperature (**Vellosillo *et al.*, 2010**). In nature, temperature changes occur more suddenly than any other growth factor of stress. In some plants, when this change exceeds a height from the specified limits for growth, this not only affects limiting their growth and the degree of their spread in the region, but also causes severe damage that sometimes reaches to death, While others survive these conditions, give a certain productivity, and complete their life cycle, this depends on the genetic nature of the crop variety, the degree of stress to which it is exposed, and its stage of growth (**Larcher, 1995 ; Hasanuzzaman *et al.*, 2013**). Under the influence of heat stress, the plant's production of ROS compounds increases, causing oxidative damage. The lower their production, the greater the organism's benefit from the compounds by remaining non-oxidizing, because when they are oxidized, free radicals will form in them, which negatively affects compounds, as it transforms them from a beneficial state for the cell into a non-useful state, preventing the cell from benefiting from them, and thus the death of the plant cell (**Suzuki & Mittler, 2006**).

AIMS OF STUDY

The study aims to know the harmful effects of reactive oxygen species ROS in plants and how to reduce their generation inside the plant to preserve the plant cell under heat stress.

HEAT STRESS EFFECTS

- Cellular: heat prevents the process of transcription and translation at the DNA level, and causes aggregation and denaturation of proteins, fluidity of membrane fats, slow cell division or expansion (**Rodríguez *et al.*, 2005 ; Wahid, 2007**), and programmed cell death (**Peverelli & Rogers, 2013**).
- Physiology: many physiological processes are affected by the heat of the environment in which plants grow, and dealing with heat is a complex matter that depends on the genetic nature of the plant. The life processes of most plants stabilize at a temperature ranging from above 0-35 C°, as the temperature increases, photosynthesis, respiration, enzyme activity and growth rate reach a certain limit, then all these measures tend to decrease with increasing temperature, as respiration decreases when the plant becomes It cannot tolerant the temperature as well. For photosynthesis, it is one of the most sensitive physiological processes to heat (**Crafts-Brandner & Salvucci, 2002**), While the optimum temperature ranges for most of the activity of enzymes between 30-45 C° and is damaged when the temperature rises above 60 C°, except for heat-tolerant plants, and for this all life processes have a critical temperature, after which it causes damage to the plant cell and then the death of the plant (**Źróbek-Sokolnik, 2012**). Figure 1.

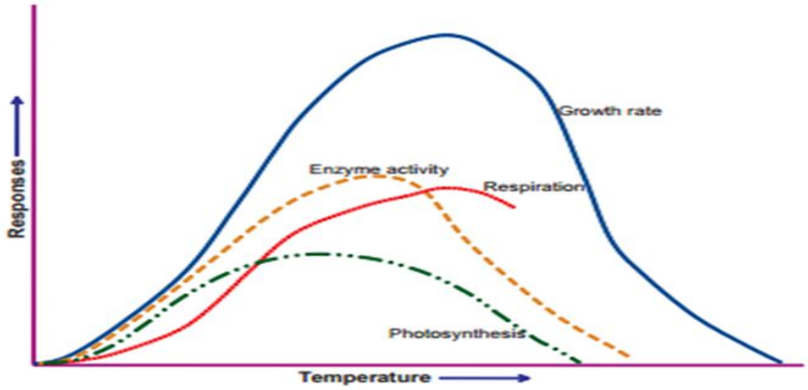

Figure (1): Effect of heat on the main physiological processes of plants (**Fitter, 2002; Zróbek- Sokolnik, 2012**)

-Biochemical: heat affects the inhibition of enzyme activity, production of reactive oxygen species ROS, the change in the properties of primary and secondary metabolites, osmotic damage, water absorption and ion transport (**Peverelli & Rogers, 2013**), In addition to affecting the synthesis and accumulation of plant hormones (**Hassan *et al.*, 2021**).
-Morphology: heat affects the decrease in the size of the plant tent as a result of the decrease in the rate of plant growth and thus the seed yield (**Schwarz *et al.*, 2020**).

EFFECT BIOCHEMICAL OF HEAT STRESS

Reactive Oxygen Species ROS

The plant needs energy in all its metabolic processes, and the source of this energy is carbon and sugars that are formed in the process of photosynthesis, it is the best condition that the plant can benefit from because of its high ability to transfer, absorb, assimilate, or store, as it can be stored as it is or enter into biochemical processes, from which fats, starches, proteins, and others are produced (**Hwang *et al.*, 2019**). ROS, known as free radicals, are produced as by-products under aerobic cellular conditions continuously in chloroplasts, mitochondria and organelles in the cytoplasm of peroxisomes (**Sharma *et al.*, 2012**), there is a balance between is formed and destroyed from these products due to the necessity of their presence for the continuation of life. The ability of the organism to convert air and food into chemical energy depends on a series of free radicals (**Huchzermeyer *et al.*, 2022; Thirupathi *et al.*, 2011**). Under heat stress, the plant loses carbon, ATP production decreases, and ROS production increases (**Huang *et al.*, 2012**), this increase does not lead to the desired goal, as free radicals are generally unstable, highly interactive, and short-lived, especially the hydroxyl radical OH^- the most toxic to plants, free superoxide O_2^- and hydrogen peroxide H_2O_2 (**Potters *et al.*, 2007**), As it causes many physiological disorders in the plant, such as decreased activity of the photosystem II (PSII), and negatively affecting pigments, including chlorophyll and its fluorescence (**Feng *et al.*, 2014**). Affects polymeric proteins and disintegrates them into soluble forms, which leads to early senescence of leaves (**Young *et al.*, 2004**). Depolarizing cell membranes and causing Thylakoid membrane damage reduce the efficiency of photosynthesis (**Georgieva, 1999**). Destruction cell components to cause severe damage to their fats and proteins, especially their genetic material DNA leading to cell death (**Apel &**

Hirt, 2004 ; Nunes-Silva & Freitas-Lima, 2015). which is of two types, apoptosis, is represented by a series of organized steps that lead to self-destruction and localization of cells This type occurs as a result of cell shrinkage, condensation of the cytoplasm, chromatin, and nucleus, DNA disassembly (**Karuppanapandian *et al.*, 2011**), so dead cells gather in the tissues of certain organs of the plant. Whereas, necrosis occurs when the cell is severely injured, preventing it from adjusting the balance of fluids and ions, and causing it to explode, releasing its contents between the cellular spaces, which exposes neighboring cells to harm or death, and this type is irregular (**Gadjev *et al.*, 2008**), In both cases, cell death depends on the concentration of ROS, as the cell dies by necrosis when exposed to high concentrations that cause toxicity.

Plant tolerance of stress at a certain stage of its different stages of growth does not mean that it is tolerant in other stages, as the stages of plant growth differ in their tolerance to different stresses, including temperature, because each stage is linked to a large number of genes, Therefore, many plant species, in order to tolerance this degree of stress, have to either reduce ROS synthesis or increase the plant's ability to remove ROS (**Bernhard *et al.*, 2022**). ROS is not considered as a toxic by-product only, but an important component that affects the amount of plant defense response under stress through its interaction with many cellular components, causing damage that leads to cell death, In addition to its effect on the expression of many genes involved in various metabolic pathways and signal transfer (**Karuppanapandian *et al.*, 2011; Mittler *et al.*, 2004**).

COUNTERACT THE NEGATIVE EFFECTS OF (ROS).

Use of chemicals

Many chemicals played an important role in reducing the harmful effect of heat stress and increasing the effectiveness of antioxidants, including exogenous additions like the foliar spraying of osmotic protective compounds such as Proline Pro, which increased the plant content of K^+ and Ca^+ elements, Phytohormones such as Salicylate SA, signal molecules Nitric Oxide NO, Microelements such as selenium Se (**Hasanuzzaman *et al.*, 2013 ; Rasheed *et al.*, 2011**), Plants, like all other living organisms, need nutrients of both major and minor types for growth and development and adding them plays an important role, some of which are related to the metabolism process, and some of them enter the enzyme system of the plant (**Waraich *et al.*, 2012**).

Agricultural practices

The optimal planting date is one of the most important agricultural practices through which it is possible to obtain the best growth of plants and achieve the maximum grain yield during which the plant avoids heat, especially in the late stages the stages of filling the grain, and it is preferable to choose early- ripening genotypes for their ability to escape from heat (**Al-Karaki, 2012**). Heat stress has been associated with a lack of water, which plants face by closing the stomata and increasing evaporation for the purpose of cooling without it, the leaf temperature may reach 50 °C or more. Therefore, water management is considered in terms of scheduling irrigation based on the critical growth stage and the efficiency of the method of adding it and applying it on the basis of soil moisture, which can be maintained by covering it either with straw, which reduces evaporation, or with organic matter, which improves the efficiency of water and nitrogen use (**Chen *et al.*, 2007; Singh *et al.*, 2011**), And the fact that the tolerance of heat stress in plants depends on the perception of stimulation, signal, and the regulation of physiological and chemical processes (**Xiao *et al.*, 2017**), Therefore, the process

of priming by all its methods is effective in improving plant tolerance to various stresses, as this process is not related to seeds only, but to the whole system of the plant. Therefore, the plant reacts to stresses faster and with high efficiency, including heat stress as a result of metabolic processes (metabolism) that occur before germination, which lead to change in hormones, glucose, ROS, and other signals (**Balmer *et al.*, 2015; Xiao *et al.*, 2017**).

CONCLUSION

Climate change is a reality that has far-reaching effects on food security, as one of the consequences of this change is the rise in temperatures, which is considered one of the main types of environmental stresses that limit the growth and development of plants. This is due to its devastating effect on the metabolism process, cellular homeostasis, as well as disturbances in the main physiological processes of the plant, as well as the resulting imbalance between the production of toxic compounds ROS known for its effect. It is dangerous for plant cells and their removal of toxicity.

RECOMMENDATIONS

It is recommended to attention must be paid to genetic techniques to produce varieties that tolerate adverse climates, to use water efficiently, and to maintain the land use system to ensure adequate food production to face this change.

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