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IMPACT OF HIGH TEMPERATURE ON PHYSIOLOGICAL TRAITS OF RICE

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Rice is the main cereal crop on which more than 50% of the livelihood is dependent. Besides it is also a primary source of caloric intake among majority of the population. Rice during its life cycle faces obstacles in form of both biotic as well as abiotic stress. Of the abiotic stress rise in temperature has become a primary concern keeping in view the global warming associated with climate change. The Intergovernmental Panel Change on Climate Change (IPCC) stated that there is more than 50% chance that global temperature rise will reach or surpass 1.5 degrees^{o}C (2.7 degrees F) between 2021 and 2040 and under a high-emissions pathway, specifically, the world may hit this threshold even sooner — between 2018 and 2037.

Rice is a C-3 plant and is influenced by rise in temperature. Every stage of its life cycle is affected by increase in temperature however, it is the flowering and booting stage in particular which is highly sensitive to increase in ambient temperature. Increase in temperature affects the germination, tillering ability, leads to reduction in spikelet fertility, affects the grain filling and ultimately results in reduction of yield.

Impact of High Temperature on Physiological Traits

Cell membrane thermostability: Sustained function of cellular membranes under stress is pivotal for processes such as photosynthesis and respiration. The first impact of rise in temperature is alteration in the membrane permeability and its fluidity leading to electrolyte leakage. These are mainly due to changes in the lipid composition or interactions between lipids and specific membrane proteins. Heat stress accelerates the kinetic energy and movement of molecules across the membranes thereby loosening chemical bonds within molecules of biological membranes. This makes the lipid bilayer of biological membranes

more fluid by either denaturation of proteins or an increase in unsaturated fatty acids (Savchenkoetal.,2002).

Chlorophyll fluorescence: Photosystem II indicates the overall photosynthetic efficiency of the plant and of all the components it is affected the most by high temperature stress by reduction in electron transport (Mathur et al, 2011). It is also considered as heat sensitive component of photosynthesis. Fv/Fm that indicates the PSII photochemistry is used as a selection criterion under heat stress condition. Apart from PSII, D1 and D2 proteins are also disrupted by heat stress.

Gas exchange traits: Exposure of plants to heat stress leads to structural alterations in chloroplast protein complexes, reduced activity of enzymes (Ahmad et al, 2010) as the enzymes involved in C3 cycle are inhibited even at lower levels of heat stress. All the gas exchange traits viz., photosynthetic rate, stomatal conductance, transpiration rate and intercellular CO_2 concentration are affected by heat stress. The most important and sensitive physiological phenomenon effected by high temperature stress is photosynthesis mainly due to the influence on the activity of Rubisco, the key enzyme for photosynthetic regulation.

Photosynthetic pigments: Chlorophyll is an important plant pigment involved in photosynthesis. Reduction in chlorophyll content under high temperature stress is due to the enhanced activity of chlorophyllase. The reduction in chlorophyll content can be either because of impaired biosynthesis or degradation of the pigment or both. This reduction may result in damage to the electron transport ultimately reducing the photosynthetic ability of plants. Apart from chlorophyll there are accessory pigments called carotenoids located in light harvesting complex that play an important role in light harvesting as well as photoprotection. These pigments are also affected with increase in temperature.

Grain filling: It is the most important process occurring in the rice grain and the rate of grain filling accompanied with duration decides the grain weight. This process is highly influenced by heat stress. Under low to moderate heat stress, a reduction in source and sink activities may occur leading to severe reductions in growth, economic yield and harvest index. Grains developed under high temperature appear chalky and have lower amylose content. High temperature at grain filling period affects the process thus resulting in reduction in seed set and weight and ultimately reduction in yield. The underlying reason may be due to diversion of photosynthates to cope up with heat stress instead of utilizing for the process of grain filling.

Conclusion

Rice is influenced by increase in temperature. High temperature exerts negative effect on plant growth and development and results in reduction of yield of the plant. Temperature is an external ambient factor which cannot be controlled. The IPCC predicts an increase in global temperatures over the coming years. Hence, to address this issue identification or development of tolerant rice varieties that can withstand high temperatures is the need of the hour.

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