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REVIEW ON EFFECTS OF HEAT STRESS ON RICE.

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Abstract

Rice is a global food crop and an economically important crop. Heat stress, the ultimate cause of climate change, leads to various physiological stress on rice. Heat stress significantly reduced yield by affecting the germination, tillering stage, and flowering stages. Moreover, a reduction is more serious at the flowering stage causing minimal effects in other stages. This review summarized how heat effects affect rice at different stages. If special measures to reduce heat stress are not taken, there will be a serious threat to global food security in the coming days. So, heat stress should be managed by using various genetic approaches developing thermo resistance rice varieties, and adjusting rice planting.

Keywords: Climate change, flowering, heat stress, yield.

Introduction

Rice is one of the most important food crops in the world; it contributes to both food security and income generation, particularly in developing countries (Khush,2005) Rice is a source of life for major populations of the world but increasing temperatures due to different reasons have affected various physiological processes in the plant. Global circulation models project that the global temperature is likely to increase by 1.4 to 5.8°C by the end of the 21st century because of the projected increase in the concentrations of all greenhouse gases (IPCC, 2001). Through its life cycle, the production of rice is greatly influenced by various abiotic stress including water, temperature, light, and soil. According to a recent IPCC estimate, if no effort is made to mitigate the implications of rising

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temperatures and hydrologic disruption, agricultural productivity in South Asia might decrease by 30% by 2050 (Alcamo et al.,2007)and (Adiloğlu et al., 2016)

Heat stress is often defined as the rise in temperature beyond a threshold level for a period of time sufficient to cause irreversible damage to plant growth and development (Wahid et al., 2007). Although the productivity of crops becomes high with rising temperature, it declines due to heat stress when the temperature exceeds the optimal range. The decline in rice yield is seen due to an increase in night temperature.

Review and Discussion:

Effects of heat stress on rice:

Heat stress during the vegetative stage of rice has a negative influence on germination, individual plant height, tiller number, and dry weight (Krishnan et al., 2011). Rice germinates well in between temperatures of 30-35°C, and cannot germinate well in very low and very high temperatures (Society & Journal, 2016). A recent study shows a negative correlation between increased temperature and crop yield, especially between rice, wheat, and barley (Zhang et al., 2017). In rice plants, high-temperature stress has a significant impact on plant anatomical structures at the subcellular as well as tissue and cellular levels(Krishnan et al., 2011). Because rice plants can only endure a narrow range of temperatures, particularly during the flowering season, fertilization and seed formation are impaired, resulting in a reduced yield

- **Heat stress during vegetative stage:**

  During germination period, high temperature leads to excessive water loss ,yellow leaves and results in improper seedling and root growth (Jun Liu et al., 2018).When exposure to HS (45°C for 72 hrs.), seedlings of indica cultivar are more resistant than japonica cultivar (Jiajia Liu et al., 2016). Heat stress during tillering stage results in reduced tiller number, wilting, yellowing of leaves. Temperatures ranging from 40°C to 45°C in a Thailand greenhouse substantially reduced the seed-setting rate and grain yield of various rice cultivars. An essential yield element that is sensitive to high temperatures is the seed-setting rate (Prasad et al., 2006).

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- **Effects of heat stress on rice reproductive stage:**

  Rice is most susceptible to heat stress during heading stage and flowering stage (Prabhudesai & Viswanathan,1978) and (Mackill et al.,1982). High temperatures during flowering and grain-filling impair yield by causing spikelet sterility and shortening the grain-filling period (Wang et al., 2019). High temperature mostly affects rice plants during the anthesis, i.e., at the time of opening of flowers, thereby decreasing the fertility of the spikelet (Sarangthem et al., 2021).High temperatures before anthesis had a less effect on sterility (Prabhudesai & Viswanathan, 1978). HS impairs panicle initiation and spikelet development, leads to deformed floral organs, and reduces spikelet number and size. HDNT(High day night temperature) considerably reduces both panicle number and spikelet number under high-temperature stress, but spikelet number per panicle is more prone to decline than panicle number under either HNT or HDT situations (Xu et al., 2020).

- **Effect of heat stress on grain filling stage.**

  Rice requires lower night temperature during the grain filling period (Krishnan et al., 2011). Owing to high temperatures during the ripening period, abnormal morphology and coloration occur in rice, probably due to reduced enzymatic activity related to the grain filling, respiratory consumption of assimilation products and decreased sink activity (Krishnan et al., 2011). Rice plants in the panicle initiation stage will face high temperatures as a result of delayed sowing dates and uncertain weather, which will have a negative impact on spikelet production and floral growth (Wang et al., 2019). During the ripening stage, HDT, HNT, and HDNT treatments reduced grain filling duration, which was expected to account for grain weight reduction (Kim et al., 2011); (Shi, Yin, et al.2017).Because of the high temperature, the degree of sterility might range from a few empty glumes to the entire panicle being devoid of grains (Krishnan et al., 2011).

Conclusion

Heat stress is one of the climatic risks that is faced worldly. Rice is affected by heat stress during germination, tillering, flowering stage, grain filling stage resulting yield reduction. Low germination rate, a smaller number of tillers, spikelet sterility, reduced enzymatic activity impairs yield altogether. Selection of transgenic rice varieties with better stress tolerance, adjusting rice planting, and strengthening local institutions can help manage the heat stress effects.

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