MARUMEGH

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Available online at www.marumegh.com

 ISSN: 2456-2904

CROP IMPROVEMENT STRATEGY FOR HEAT STRESS IN WHEAT

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Background

In 21^{st} century, global crop production threatened by climate change and it is one of the most important challenge to supply sufficient food for the increasing population. According to Intergovernmental Panel on Climate Change (IPCC), the carbon dioxide, methane and other greenhouse gases are accumulating in the environment at unexpected rates and will increase temperature by 2.5 ^0C to 4.3 ^0C by 2080 in the crop growing areas of the world. Rising temperature, decreasing water resources, flood, desertification and extreme weather will severely cause crop production.Heat stress or high temperature is major abiotic stresses which limit theproductivity of various crops including wheat in arid, semiarid, tropical, andsubtropical regions of the world (Choudhary *et al.* 2014). A detailed mechanism of heat tolerance through genetics, physiology and selection of germplasm and methods will facilitate the development of heat.It is predicted that increases in `greenhouse gas' concentrations will result in a rise in mean temperatures in coming years (Choudhary *et al.* 2015). Although yields of temperate crops increase with enhanced CO_2 concentrations, this may be offset by the negative effects of warmer temperatures in determinate crops.

Consequences

Heat stress is a major environmental stress which limits the productivity of wheat in most cereal growing areas of the world. Wheat is very sensitive crop with respect to temperature. Terminal or post anthesis heat stress frequently limits production of wheat. One of the reasons for reduced productivity of wheat is poor seed setting at increased temperature. This may be due to abnormal microsporogenesis at high temperature. In wheat temperature required for anthesis and grain filling during crop growth range from 12 to 22^0C. Exposure to temperatures above this can significantly reduce grain yield. Heat stress during the reproductive phase is more harmful than vegetative phase and can cause increases floret abortion, pollen sterility, tissue dehydration, lower CO_2 assimilation, and increased photorespiration due to the direct effect on grain number and dry weight(Choudhary *et al.* 2015).The duration of grain filling in cereals is determined principally by temperature. The rate of grain filling can decrease after anthesis due to impose of higher temperature and subsequently losses to the crop production (Wardlaw *et al.*, 1989). This increase temperature at anthesis stage affect severely grain number, 1000 grain weight, spike number and the subsequently leads to smaller grain and reduced final yield. The physiological effects of high stress onfertility traits viz. pollen sterility, no. of spikelet fertility,no. of grain per ear head and no. of spike per plantunder heat stress conditions are more pronounced. Most studies in common wheat have focused on heat stress exclusively at or around anthesis and indicate that male reproductive development is generally more vulnerable to damage than female. These suggested that heat stress at or just before anthesis reduced pollen fertility, no. of grain per ear head and no. of spikelet fertility of wheat lines, but did not change no. of spike per plant. In addition, pre-fertilization stages aremore sensitive to heat stress than post-fertilization stages. Yield reduction in wheat under high temperature stress is caused by accelerated phasic development, reduction in photosynthesis, accelerated senescence, increase in respiration and inhibition of starch accumulation in developing kernels.

Adaption of strategy

Adaptation strategies are increasingly major concern of scientific research and it is most challenging aspect to maintain genetic resources of crops to biotic and abiotic stresses. Adjustment of breeding and agronomic practices like changing genotypes with heat/salinity stress tolerance, varieties with altered traits, altering irrigation practices, planting and harvest time and remote sensing for precision phenotyping can be used to reduce production risk. In addition to these adaptation trends, new developments in agricultural biotechnological are being used to increase production of crops by reducing application of pesticide and fertilizer.

Biotechnological approaches

In recent years, molecular markers have been utilized for a variety of applications including evaluation of genetic relationships between individuals, mapping of useful genes, construction of linkage maps, marker assisted selections and backcrosses, population genetics and phylogenetic studies (Choudhary *et al*. 2016). Biotechnology offers immense application through marker-assisted selection (MAS), QTL mapping, tissue culture technique, gene cloning, transformation techniques and terminator technology in crop production. These techniques allows the specific identification, isolation, alteration of gene and gene function to for production of new crop varieties and desirable traits. Molecular markers are known for indispensable role due to high availability, reproducibility and polymorphism nature and among them microsatellites or simple sequence repeats are highly studied marker system in plants genetics and breeding for heat stress due to multiallelic nature, extensive genome coverage, co dominant inheritance, high throughput genotyping (Choudhary *et al*. 2016). Currently, many crops with altered traits has been successfully cultivated, among them are, cotton and corn for insect resistance, soybean for herbicide resistance and tomato for delayed fruit ripening.

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