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Breeding for heat tolerance in wheat, where we are?

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Breeding for heat tolerance in wheat has been a subject of high significance for warmer areas from the day wheat became a staple crop in these regions. For a long time, terminal heat stress used to be the major issue. However, rising temperatures due to climate change has made heat stress tolerance at early growth stages equally important. In fact, heat stress is becoming more and more unpredictable, occurring at any stage of crop growth and, hence, climate-resilient wheat is the demand of the time. Over years, a successful breeding approach for heat tolerance depended on planting under late-sown conditions, followed by selection for lines that maintained better yields and kernel weight. It was also combined with selecting for early-maturing lines that can escape heat stress and yield well in heat stressed environments. Physiological traits, especially canopy temperature, also became a favorable trait for breeding for heat stress tolerance. A simultaneous enhancement of grain yield potential and heat stress tolerance of early-maturing wheat lines was found beneficial in South Asia to enhance productivity under temperature stress, while reducing the water use by cutting the last irrigation. In last decade, molecular markers were explored for heat tolerance. However, these markers so far lacked robustness and could not become a regular part of most breeding programs and remained restricted to identification of parental lines for breeding programs. Recently, the concept of genomic selection (GS) was introduced for breeding climate-resilient wheat. Our recent experience with GS on breeding climate resilient wheat for South Asia has demonstrated its ability to improve genetic gains during selection, however, phenotyping under heat stress remains critical to train GS models.

How rising temperatures would be detrimental for cool and warm-season food legumes

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Rising temperatures are a major concern for the productivity of food legumes, grown in winter as well as summer-season, especially in tropical and sub-tropical regions. Our studies have indicated marked damage to the reproductive stage, resulting in reduction in pod set and seed yield of chickpea, lentil (cool-season legumes) and mungbean (warm-season legume) under high temperatures. Studies done in controlled and outdoor environments (late sowing) revealed that temperatures >35/20°C (as day and night) were highly detrimental for winter-season legumes; while >38/25°C markedly affected the summer-season legumes (mungbean). Urdbean, (a summer season legume), was found to be relatively more tolerant. The degree of damage varies depending upon the duration, timing and severity of stress. Among the reproductive components, pollen grains were more sensitive, became deformed and showed reduction in pollen viability, reduced germination and pollen tube growth. Stigma receptivity and ovule viability were also inhibited, which affected the pollen germination on stigma surface and restricted tube growth through style, and impaired fertilization to cause flower abortion. Assessment of the physiology of leaves, anthers and styles indicated decrease in sucrose production in all these organs due to inhibition of enzymes, which possibly affected the structural and functional aspects of the pollen grains and tube growth through style. Seed filling is another stage which becomes impaired as a result of inactivation of enzymes related to sucrose production, causing inhibition in sucrose translocation into seeds. Additionally, the composition of the seeds was adversely affected, resulting in small size and poor quality of seeds. The data related to these processes would be presented. Genetic variation for heat tolerance exists in our target legume crops, which needs further probing and use of heat tolerant germplasm in breeding programs. Screening for high temperature tolerance has led to identification of few heat-tolerant genotypes, which are able to maintain their gamete function at high temperature, unlike the sensitive genotypes. Future studies should focus on high throughput phenotyping techniques and/or physiological, biochemical or genetic markers that control the reproductive function. Information about the effects of heat stress on reproductive biology and seed filling events of chickpea, lentil and mungbean will be discussed.