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NIPGR scientists characterize new regulators for heat stress tolerance in tomato

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New Delhi, March 30: Global temperatures are relentlessly increasing worldwide. They have risen by up to 2.5 degrees Celsius in the past few decades. This is having significant impact on crop yield and quality leading to a threat to food security and biodiversity. Unravelling the naturally evolved mechanistic signaling frameworks using naturally resistant/sensitive landraces/cultivars to heat stress conditions could help harness novel stress-responsive regulators to develop heat stress resilient plants.

Tomato, which is ranked among the world's most important cash crops, is highly sensitive to increased temperatures. Tomato cultivation has also increased significantly from the conventional cool climatic zones to the warmer regions of the world including the Indian sub-continent. A team of researchers at National Institute of Plant Genome Research have sought to **characterize new regulators for heat stress tolerance in tomato** with a view to help develop heat stress resilient tomato plants.

The team first selected the best 'contrasting-pair' of tomato cultivars by comparing nine cultivars from the Indian-sub continent climatic zones exhibiting either heat stress tolerance or sensitivity using survival assays, biochemical/physiological parameters and yield related traits. Comparative heat-responsive transcriptomic signatures between the leaves of the best contrasting cultivar-pair, viz., CLN1621L (CLN, tolerant) and CA4 (sensitive) under heat stress, identified that more than 50% of differentially expressing genes (DEGs) do not share a conserved response to heat stress highlighting redundant as well as cultivar-specific expression pattern.

Interestingly, we find only 21 DEGs that are antagonistically regulated between CLN and CA4 upon heat stress. The direct role of many of these genes in hyperthermal stress tolerance is either totally lacking or is very limited. Among them are genes that are implicated in plant pathogen defense response like the HXXXD-type acyl-transferase family proteins (ASAT) and Pin-type proteinase inhibitors family as well as *Notabilis*, that codes for an enzyme regulating rate limiting step of Abscisic acid hormone biosynthesis.

Functional evaluaton by overexpression and knock-down for two antagonistic genes, viz., *Notabilis* and *ASAT* that exhibit enhanced trancripts in not only the tolerant CLN but also another tolerant variety Pusa Sadabahar and are down-regulated in two most sensitive varieties, CA4 and Pusa Ruby established their role in enhancing thermotolerance of tomato plants.

Further, functional analysis for thermotolerance by silencing and overexpression of another antagonistic gene, a serine-proteinase inhibitor family protein viz., Pin-type proteinase inhibitor-II (PI-II) that was upregulated in both the sensitive varieties confirmed that its abundance imparts thermosensitivity to tomato plants. Our analysis revealed that *Notabilis, ASAT* overexpression and *PI-II* silenced plants are enriched in heat stress response (HSR) genes like HSFs and HSPs, as compared to vector control plants.

These results ascertain *Notabilis*, *ASAT* as positive and PI-II as negative regulator of many HSR genes and thermotolerance. We have also functionally validated three previously uncharacterized ethylene response factor (ERF) transcription factors; their overexpression significantly enhanced tomato seedling survival under heat stress as compared to vector control plants. In addition, many promising genes have been identified which can serve as excellent candidates for enhancing thermotolerance in tomato and be assessed and used in other crop plants.

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