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One gene to tackle all stresses

Engineered plants may withstand drought or infections

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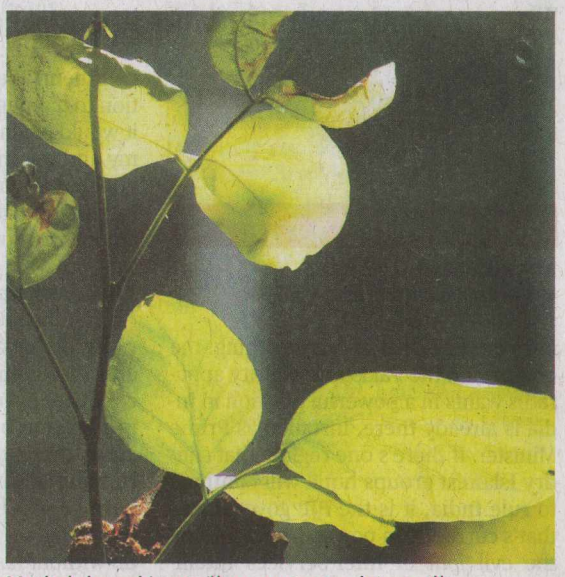
Different types of stress can affect the life of plants including that induced by pathogens (biotic stress) and that caused by non-living entities such as drought, osmotic stress, chemical or salt stress and so on (abiotic stress). For a long time, researchers have been trying to understand the genetics of stress, and now a collaboration of scientists from Bengaluru's National Centre of Biological Sciences (NCBS) and Indian Institute of Science (IISc) has discovered a single gene whose expression controls the plants' response to both biotic and abiotic stress. This finding can be used to engineer plants that can withstand, for instance, drought or bacterial infections. The research has been published in *Plant Molecular Biology*.



Methylglyoxal in small amounts regulates cell-proliferation, but above a certain level it can be toxic. ▪ C. V. SUBRAHMANYAM

Unrelated stress

"Previous studies at best identified genes that provide resistance to diverse abiotic stresses that are connected physiologically. For example, drought and salt stress are related and one single gene could provide resistance to both," says P.V. Shivaprasad, professor at NCBS. The novelty of this research is that it proposes that by expressing a single gene, it is possible to develop resistance in plants to various diverse and unrelated types of stress.

It has been known that the accumulation of an aldehyde - methylglyoxal - above a certain level can be toxic in all organisms. "Under normal developmental conditions, methylglyoxal levels remain very low (30-75 microM) and this regulates processes such as cell proliferation and their survival, and control of toxins," says Prof. Shivaprasad. However, the problem begins when this level increases beyond an optimum. Methylglyoxal is highly toxic in all organisms including humans at higher concentrations. "High levels of methylglyoxal targets proteins and DNA and modify them in such a way that they are non-functional," he adds.

Studying tobacco plants, the researchers have shown that overexpression of heat shock protein (Hsp31), which has the capacity to detoxify the plant cells of methylglyoxal, can render them highly tolerant to both biotic and abiotic stress. This protein - Hsp31 - is very similar to the PARK7 protein in humans which is linked to early onset of Parkinson's disease.

A timeline

Sudhir Sopory of Indian Institute of Science, Bengaluru (IISc) has done pioneering work on related proteins in plants and also demonstrated that their expression can provide abiotic stress tolerance in plants. Patrick D'Silva, also from IISc, had identified HSP31 in yeast as a methylglyoxalase that can offer abiotic stress tolerance in yeast. The NCBS team collaborated with the latter, whose lab provided clones as well as helped them with the biochemistry.

"We show that plant proteins similar to PARK7 are much more potent in their ability to remove toxins... It will be interesting to see if plant PARK7-like proteins can provide cure to neurological diseases through their activities," says Prof. Shivaprasad.