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Review

Heat shock proteins (HSPs) and acquisition of thermo tolerance in higher plants

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SUMMARY
Plants are sessile organisms and their ability to adapt to stress is crucial for survival in natural environment. The analysis of stress responsiveness in plants is an important route to the discovery of genes conferring stress tolerance and their use in crop improvement programmes. Many observations suggested a relationship between stress tolerance and heat shock proteins in higher plants but role of individual protein is yet to be characterized. A correlation between HSP induction and adaptation to stress in higher plants is the subject of this review article.

Key words : HSPs, Thermotolerance, Higher plants

Heat stress often is defined as where temperatures are not enough for sufficient time that they cause *irreversible* damage to plant function or development. In addition, high temperatures can increase the rate of reproductive development, which shortens the time for photosynthesis to contribute to fruit or seed production. High day temperatures can have damaging effect associated with hot tissue temperatures or indirect effects associated with the plant-water deficits that can arise due to evaporative demands. Evaporative demand exhibits near exponential increases with increase in day time temperatures and can result in high transpiration rates and low plant water potentials. Plants can be damaged in different ways by either high day or high night temperatures and by either high air or high soil temperatures. Also, crop species and cultivars differ in their sensitivity to high temperatures. Cool-season annual species are more sensitive to hot weather than warm-season annuals. The extent of heat stress that can occur in a specific climatic zone depends on the probability of high temperatures occurring and their duration during the day or night. Where a global climatic change is occurring these probabilities may not be predicted well based on historical records for specific locations. Heat stress is a complex function of intensity (temperature degrees), duration and rate of increase in temperature. The magnitude of heat stress rapidly increases as temperature increases above a threshold level and complex acclimation effects can occur that depend upon temperature and environmental factors.

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Stress and stress fields:

Stress is clearly defined as the point or degree of bending of an elastic system just between symptom less reversibility, irreversibility deformation or break. In medicine and biotechnology, stress is supposed to indicate all situations beyond normal, defined by the observer i.e. man. Seven stress fields and stress induced signal transduction leading to plant development have been defined for plants (Figure1 & 2 taken from Hippeli and Elstner, 1996).

Heat shock response:

The heat shock response is a ubiquitous phenomenon in all prokaryotes and eukaryotes resulting in altered gene expression and protein translation. In higher plants, the general characterization of this response have much in common with those of other organisms, including a probable role in development of short term thermal tolerance. Over the past four decades heat shock responses have been intensively studied, first in *Drosophila* and subsequently in a wide variety of animals and microorganisms (Schlesinger *et al.*, 1982; Nover *et al.*, 1984).The characterization of heat shock response in plants have been investigated in many species, Including maize, tomato, cotton, tobacco, carrot, *Chlamydomonas*, soybean, pea and millet (Key *et al.*, 1983; Pitto *et al.*, 1983).

Main Features of Heat Shock Proteins (HSPs) :

- Immediately following an abrupt shift of 8-10^{o}C above the normal growing temperature, synthesis