Plant Archives Vol. 20, Supplement 2, 2020 pp. 1938-1940 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

ROLE OF HEAT SHOCK PROTEIN IN SEED SCIENCE AND TECHNOLOGY : A REVIEW

Neha Thakur
School of Agriculture, Lovely Professional University, Phagwara-144411, Punjab, India
email:- nthakur0708@gmail.com

Abstract

Plants have inbuilt mechanisms to protect itself from harsh environmental conditions. Due to tremendous change in the environmental conditions there are certain possibilities that one can think of. One of such mechanism is presence of Heat Shock Proteins (HSP) in the plant cell. These are molecular chaperons that allow plants to survive in the higher temperature regimes by binding with the protein molecules thus preventing their disintegration due to warm conditions. HSP have role in heat tolerance, desiccation tolerance, seed development, maturation, seed germination and seed longevity. It also regulates plant cell development and working mechanism

***Keywords* :** Heat Shock Protein, seed germination, longevity, stress proteins

Introduction

Seeds, which is a fertilized mature ovule during its development gain exceptional defensive mechanisms that permit it to endure parching to amazingly low water content. It also allow it to keep up their germinability significantly after numerous long stretches of capacity. Heat shock proteins (HSPs) are molecular chaperones that are produced enormously when cells are brought to raised temperature and different pressure. They are associated with various plant cell forms like protein collapsing, transport of proteins across films, guideline of protein exercises and avoidance of irreversible protein collection (Dubrez *et al.,* 2020). Also conditions that change temperature, light condition, water status, or hormone balance lead to adjusted quality characters in plants. At the sub-atomic level, a standout amongst other described ecological reactions is the reaction to high temperature. Therefore study of Heat Shock Protein is essential from point of view of studying seed development (Liu *et al.,* 2016).

The worldwide air temperature is anticipated to increase by 0.2 °C every decade, which will prompt temperatures 1.8–4.0 °C higher than the present level by the year 2100. This forecast is making anxiety among researchers, as heat stress affects the existence of living beings, acting straightforwardly or through the adjustment of encompassing ecological segments. In plants, due to its immobility to progressively higher temperature conditions the development and formative procedures are significantly influenced causing regular mortally, by high temperature (HT) stress. Plant species adjusted to calm conditions, including crop plants, for example, soybean, pea, maize, and wheat, start to incorporate HSPs when tissue temperatures surpass 32-33°C. HSP union increments with expanding temperature, and the temperature of most extreme HSP blend is decidedly connected with every specie's ideal development temperature. This example of HSP creation proposes that the reaction is finely tuned to the physiology of the creature and further backings its natural importance (Vierling, 2003).

Several classes of HSPs have been described in eukaryotes, including plants. They are designated by their approximate molecular weights in kDa as HSP110, HSP90, HSP70, HSP60, and low molecular weight (LMW) HSPs (15-30 kDa) (121, 126) (Vierling, 2003). In presence of higher temperature outside cell surface, the protein function inside the cell also degrades as represented in Figure 1. Heat shock protein binds to the protein and prevents its degredation due to higher temperature. This is because HSPs have better hydrogen bonds, hydrophobic internal packing, better enhanced secondary structure and helix dipole stabilization. Therefore it prevents the plant from major effects of high temperature viz., inhibition of seed germination, reduction of plant growth, improper development, alteration in photosynthesis, phenology and dry matter, water loss, yield reduction in crop quality and oxidative stress. The tolerance mechanism of HSP is described in figure 2. (Hasanuzzaman *et al.*, 2013)

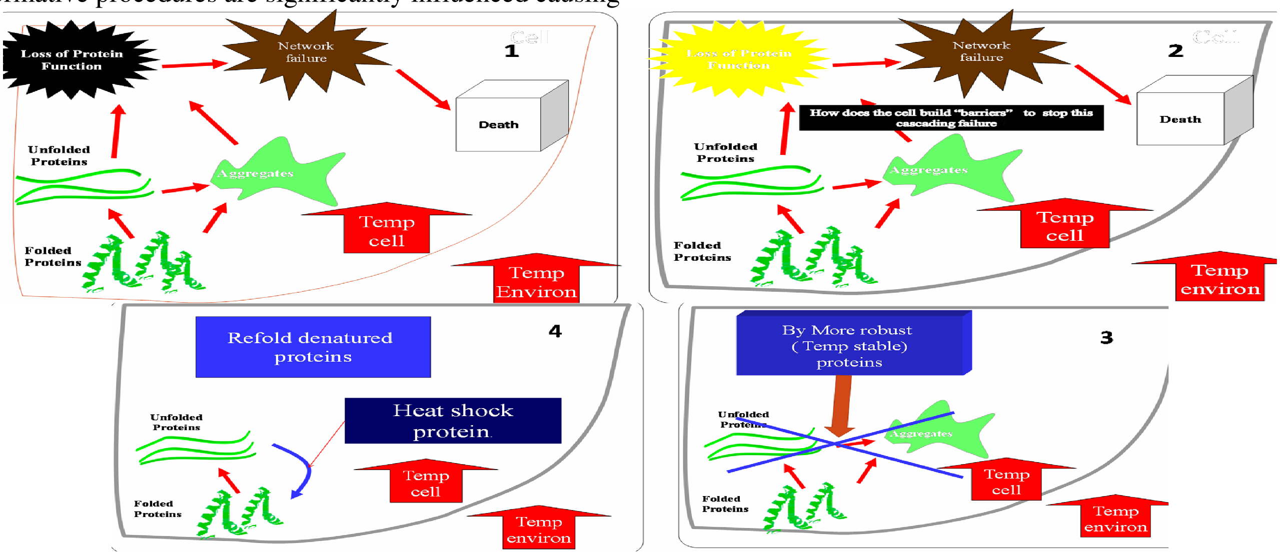

Fig. 1 : Pictorial representation of the loss of protein function inside cell

There are various varieties in crop plants that have tolerance to heat viz., Wheat (JW-3020, JW-3173, JW-3211, JW-3288, JW-3336, JW-1202, JW-1203, Chirya-3), Chick pea (JG-14 (Yezin 6), Annigeri, ILC 482 and ICCV 10), Rice (NH219, Nagina 22 (remain at 40°C temp.), Dular, IR-64) and Maize (31Y45 (Monsanto) and DKC9108 (Pioneer). Research pertaining to heat shock proteins in seed science and technology is represented in the table 1.

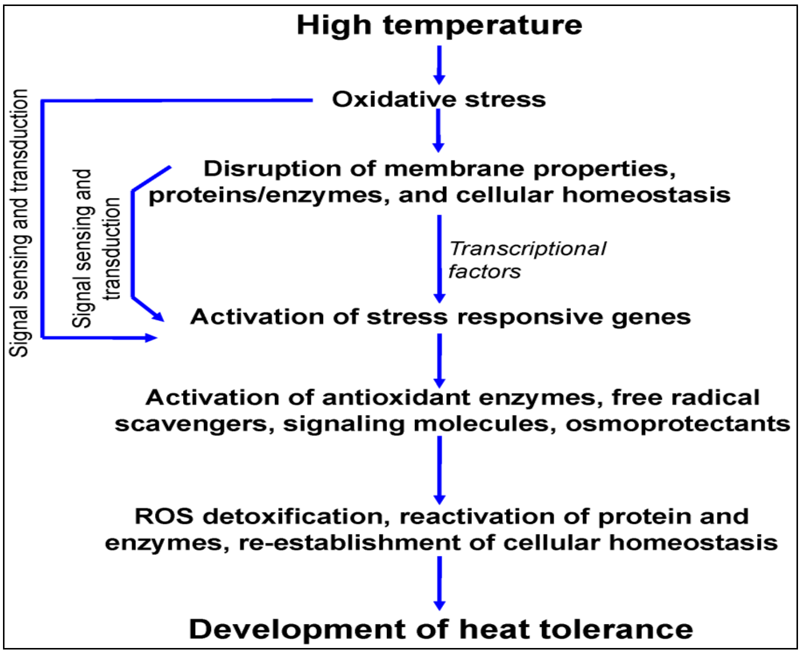

Fig. 2 : The tolerance mechanism of HSP inside plant cell

Table 1 : Research done in Seed Science and Technology in relation to Heat Shock Protein

Crop	Scientist	Inference
Sorghum bicolor and *Pennisetum americanum*	Howarth *et al.*, 1989	HSPs is essential for development of thermotolerance in seeds
Wheat	Helm *et al.*, 1989	weaker heat shock responses in low vigor seed lots as compared to their high vigor counterpart
Brassica campestris (rapa) L.	Bettey *et al.*, 1998	post-harvest drying of seeds promoted HSP synthesis
Arabidopsis	Wehmeyer and Vierling, 2000	there exist correlation in reduction in the sHSPs 17.4 and desiccation intolerance in seed
Pea	Stupnikova *et al.*, 2006	HSP22 in seed mitochondria and lipid composition lead to heat tolerance in seed
Arabidopsis	Su and Li, 2008	Hsp70, promoted seed germination
Jatropha curcas	Omar *et al.*, 2011	During maturation of seeds JcHSP-1 and JcHSP-2 heat shock proteins contributed for cell protection and seed development
Sunflower	Personat *et al.*, 2014	HSP viz., HaHSFA4a and HaHSFA9 lead to transcriptional co-activation of a genetic program for longevity and desiccation tolerance in seeds
Arabidopsis and tomato	Ma *et al.*, 2019	HSP24.7 positively controls seed germination through generation of temperature-dependent Reactive Oxygen Species
Arabidopsis	Kaur *et al.*, 2020	OsHSP18.2 enhanced seed vigour and longevity

Conclusion

Plants show a chain of reaction to high temperatures and different pressure that change its development at all formative stages. Stress proteins helps plants to recover from heat stress without causing any damage to the protein structure inside cells. Therefore this tendency of HSPs or Transcription factors (TFs) is considered as a potential application for improving seed life span and resistance to any sort of biotic or abiotic stress to plants during developmental and maturity phases of seed.

References

Bettey, M.; Sinniah, U.R.; Finch-Savage, W.E. and Ellis, R.H. (1998). Irrigation and seed quality development in rapid-cycling *Brassica*: accumulation of stress proteins. Annals of Botany, 82(5): 657-663.

Dubrez, L.; Causse, S. and Borges, B.N. (2020). Heat-shock proteins: chaperoning DNA repair. Oncogene 39**:** 516–529.

Hasanuzzaman, M.; Nahar, K.; Alam, Md. M.; Roychowdhury, R. and Fujita, M. (2013).

Physiological, biochemical, and molecular mechanisms of heat stress tolerance in plants. Int. J. Mol. Sci., 14: 9643-9684.

Helm, K.W.; Nancy, S.P. and Rollin, H.A. (1989). Heat shock response of germinating embryos of wheat: effects of inhibition time and seed vigor. Plant Physiology, 90(2): 598-605.

Howarth, C. (1989). Heat shock proteins in Sorghum bicolor and *Pennisetum americanum* L. Genotypic and developmental variation during seed germination. Plant, Cell & Environment, 12(5): 471-477.

Kaur, H.; Petla, B.P.; Kamble, N.U.; Singh, A.; Rao, V.; Salvi, P.; Ghosh, S. and Majee, M. (2015). Differentially expressed seed aging responsive heat shock protein OsHSP18. 2 implicates in seed vigor, longevity and improves germination and seedling establishment under abiotic stress. Frontiers in Plant Science, 6, 713.

Liu, Y.; Li, Y. and Lu, X. (2016). Regulators in the DNA damage response. Arch Biochem Biophys., 594: 18–25.

Ma, W.; Guan, X.; Li, J.; Pan, R.; Wang, L.; Liu, F.; Ma, H.; Zhu, S.; Hu, J.; Ruan, Y.L. and Chen, X. (2019). Mitochondrial small heat shock protein mediates seed germination via thermal sensing. Proceedings of the National Academy of Sciences, 116(10): 4716-4721.

Omar, S.A.; Fu, Q.T.; Chen, M.S.; Wang, G.J.; Song, S.Q.; Elsheery, N.I. and Xu, Z.F. (2011). Identification and expression analysis of two small heat shock protein cDNAs from developing seeds of biodiesel feedstock plant *Jatropha curcas*. Plant science, 181(6): 632-637.

Personat, J.M.; Tejedor-Cano, J.; Prieto-Dapena, P.; Almoguera, C. and Jordano, J. (2014). Co-overexpression of two Heat Shock Factors results in enhanced seed longevity and in synergistic effects on seedling tolerance to severe dehydration and oxidative stress. BMC plant biology, 14(1): 56.

Stupnikova, I.; Benamar, A.; Tolleter, D.; Grelet, J.; Borovskii, G.; Dorne, A.J. and Macherel, D. (2006). Pea seed mitochondria are endowed with a remarkable tolerance to extreme physiological temperatures. Plant physiology, 140(1): 326-335.

Su, Pai-Hsiang, and Hsou-min, Li. (2008). Arabidopsis stromal 70-kD heat shock proteins are essential for plant development and important for thermotolerance of germinating seeds. Plant physiology ,146(3): 1231-1241.

Wehmeyer, N. and Vierling, E. (2000). The expression of small heat shock proteins in seeds responds to discrete developmental signals and suggests a general protective role in desiccation tolerance. Plant Physiology, 122(4): 1099-1108.

Vierling, E. (2003). The roles of Heat Shock Proteins in plants. Annual Review of Plant Physiology, 42: 579-620.