http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 14 (9): 558-559, 2011
ISSN 1028-8880 / DOI: 10.3923/pjbs.2011.558.559

Evolution Has Forced the Plants to Follow a Timetable

Muhammad Nouman Sohail and Mouhammad Sarwar
Asian Network for Scientific Information, Faisalabad, Pakistan

A continuous evolutionary process is the reason for existence of proliferating species in this changing ecosystem. Many species interact with each other in different ways and this interaction may have positive or negative consequences for all interacting species. Because agriculture has significant role in human life, so study based on effects or different factors responsible for damage to agriculture have always remained a hot issue among scientists. Plant pathogens are one of the important factors having significant negative effect on plants and as a result plants have evolved their own defense system against them (e.g., inducible resistance (*R*) gene mediated and basal defense mechanisms). Now-a-days a lot of research is being conducted at molecular level to employ the plant's own defense system against plant pathogens. Pathogen can attack plant at any stage of life, so a constitutively active defense system is required for their effective control. But for continuously active system plant has to pay a fitness cost associated with other physiological functions like growth and reproduction (Karban, 2011). So balance is inevitable among defense and growth related metabolic activities of plants.

Recently Wang *et al*. (2011b) explained the regulation of *R* gene mediated and basal defense system genes against biotrophic pathogen with reference to circadian clock. They categorized the resistance of *Arabidopsis* against *Hyaloperonospora arabidopsidis* (*Hpa*) isolate Emwa1. *Arabidopsis* Columbia (Col-0) carrying the *R* gene "*RPP4*" responsible for resistance against *Hpa* was analyzed for differentially expressed genes. They identified 22 differentially expressed genes in wild type (*RPP4*) and mutant (*rpp4*). Individual mutants of these 22 genes were used to collect phenotypic data of different disease related parameters and then grouped into two clusters. Mutants of first cluster were found to have defects in *R* gene mediated Programmed Cell Death (PCD) resistance, while in second cluster mutants were having poor expression of genes related with basal defense mechanism. Some mutant plants (defective in PCD) were also identified that showed the susceptibility to gram negative bacterium which indicates the involvement of these genes in Microbial Associated Molecular Pattern (MAMP) triggered basal immunity. On further investigation some genes showed active role in both *R* gene mediated and basal defense system.

To get understanding that how a gene (involved in both *R*-mediated specific and non-specific basal resistance response) is regulated, Wang *et al*. (2011b) studied the promoter region of all mutant genes. These promoter regions were found to have evening elements that were regulated (both positively and negatively) by circadian regulator (*CCA1*). In order to confirm the role of *CCA1* in plant defense regulation, mutants of *cca1*, *ztl-4* (a mutant of *ZEITLUPE*) and a line over expressing the *CCA1* were inoculated with *Hpa* Emwa1 at dawn. Both mutants (*cca1* and *ztl-4*) showed compromised resistance but the line that was over expressing the *CCA1* showed enhanced resistance indicating that it positively regulates the resistance mechanism. To further confirm the role of *CCA1* in the regulation of *R*-mediated resistance response expression of cluster 1 genes was monitored in both wild type (*CCA1*) and mutant (*cca1*) plants. A rhythmic expression of these genes was observed with maximum expression peaks at every evening but in *cca1* these genes showed diminished expression, confirming that *cca1* is activator of these genes. *Hpa* sporulation mainly occur at dawn time and this rhythmic expression of defense genes in the absence of pathogen indicates that plants are programmed to anticipate infection according to a circadian schedule. It was further confirmed by infecting wild type and mutants at dusk, consequently both wild type and mutant showed enhanced susceptibility. All of these findings suggest potential role of circadian rhythm in the regulation of plant defense system.

A circadian clock regulates the plants activities and enhances the balanced interaction between plants and its environment. Hotta *et al*. (2007) concluded on the basis of reviewed literature that circadian clock modulates the plants metabolism depending upon its environmental signals, in addition plants may react differently for the same signal at

Corresponding Author: M.N. Sohail, Asian Network for Scientific Information, Faisalabad, Pakistan

different times of day. Circadian clock oscillates the plants metabolism according to the environmental signals to make the metabolism in a rhythmic motion of nearly 24 h. Plant defense response is a highly complicated process and circadian clock plays an important role in regulating these responses (Roden and Ingle, 2009; Wang *et al*., 2011a). Light possess significant role as a stimulus in defining the plant response towards a pathogen directly or indirectly (Chandra-Shekara *et al*., 2006; Griebel and Zeier, 2008). In study conducted by Wang *et al*. (2011b) circadian rhythm of gene expression may have evolved with continuous attack of *Hpa* on plant at dawn time and to anticipate the attack of pathogen plant follow a specific rhythmic activation of defense related genes. This study conducted by Wang *et al*. (2011b) is pioneering in its linking of plant defense responses with the circadian clock. Future work will improve the understanding of plant defense regulation at the molecular level in relation to circadian control and may open up new avenues for enhancing crop protection.

REFERENCES

Chandra-Shekara, A.C., M. Gupte, D. Navarre, S. Raina, R. Raina, D. Klessig and P. Kachroo, 2006. Light-dependent hypersensitive response and resistance signaling against turnip crinkle virus in *Arabidopsis*. Plant J. Cell Mol. Biol., 45: 320-334.

Griebel, T. and J. Zeier, 2008. Light regulation and daytime dependency of inducible plant defenses in *Arabidopsis*: Phytochrome signaling controls systemic acquired resistance rather than local defense. Plant Physiol., 147: 790-801.

Hotta, C.T., M.J. Gardner, K.E. Hubbard, S.J. Baek, N. Dalchau and D. Suhita *et al*., 2007. Modulation of environmental responses of plants by circadian clocks. Plant Cell Environ., 30: 333-349.

Karban, R., 2011. The ecology and evolution of induced resistance against herbivores. Functional Ecol., 25: 339-347.

Roden, L.C. and R.A. Ingle, 2009. Lights, rhythms, infection: The role of light and the circadian clock in determining the outcome of plant-pathogen interactions. Plant Cell, 21: 2546-2552.

Wang, G.Y., J.L. Shi, G. Ng, S.L. Battle, C. Zhang and H. Lu, 2011a. Circadian clock-regulated phosphate transporter PHT4;1 plays an important role in *Arabidopsis* defense. Mol. Plant, 4: 516-526.

Wang, W., J.Y. Barnaby, Y. Tada, H. Li and M. Tor *et al*., 2011b. Timing of plant immune responses by a central circadian regulator. Nature, 470: 110-114.