From Forest Nursery Notes, Winter 2012

230. © The role of phytochrome in stress tolerance. Carvalho, R. F., Campos, M. L., and Azevedo, R. A. Journal of Integrative Plant Biology 53(12):920-929. 2011.

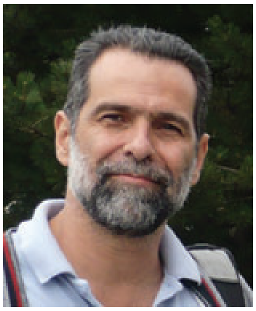
JIPB Journal of Integrative Plant Biology

Journal of Integrative Plant Biology 2011, **53** (12): 920–929

Invited Expert Review

The Role of Phytochrome in Stress Tolerance

Rogério Falleiros Carvalho[1], Marcelo Lattarulo Campos[2] and Ricardo Antunes Azevedo[3*]
[1]Department of Applied Biology, UNESP, Jaboticabal, SP CEP 14884-900, Brazil
[2]Department of Energy, Plant Research Laboratory, Michigan State University, East Lansing, MI 48824, USA
[3]Department of Genetics, ESALQ, University of São Paulo, Piracicaba, SP CEP 13418-900, Brazil
[*]Corresponding author
Tel: +55 19 3429 4475; Fax: +55 19 3447 8620; E-mail: raazeved@esalq.usp.br
Available online on 1 November 2011 at www.jipb.net and www.wileyonlinelibrary.com/journal/jipb
doi: 10.1111/j.1744-7909.2011.01081.x



Ricardo Antunes Azevedo
(Corresponding author)

Abstract

It is well-documented that phytochromes can control plant growth and development from germination to flowering. Additionally, these photoreceptors have been shown to modulate both biotic and abiotic stress. This has led to a series of studies exploring the molecular and biochemical basis by which phytochromes modulate stresses, such as salinity, drought, high light or herbivory. Evidence for a role of phytrochromes in plant stress tolerance is explored and reviewed.

Keywords: abiotic stress; biotic stress; photoreceptors; phytochromes; stress modulation.

Carvalho RF, Campos ML, Azevedo RA (2011) The role of phytochrome in stress tolerance. *J. Integr. Plant Biol.* **53**(12), 920–929.

Introduction

Light is a major environmental signal influencing a multitude of steps in plant development such as seed germination, carbon assimilation, stem elongation, leaf morphology, flowering and many others. For this reason, the detection and measurement of light quality is essential for plants to thrive. There are three main groups of photoreceptors that control virtually all types of plant responses to light (Carvalho et al. 2011a). Phytochromes absorb maximally in the red (R; ∼660 nm) and far red (FR; ∼730 nm) regions of the spectrum (**Figure 1A**, see more details below) (Essen et al. 2008; Yang et al. 2008), while the cryptochromes and phototropins detect ultraviolet (UV)-A (320–400 nm) light (Sancar 2003). However, phytochromes are still the best characterized and most extensively studied type of photoreceptors, which are encoded by a small gene family in plants; for example, there are five phytochrome genes (*PHYA* to *PHYE*) in *Arabidopsis thaliana* and *Solanum lycopersicum* (*PHYA*, *PHYB1*, *PHYB2, PHYE* and *PHYF*), three *PHY* genes (*PHYA* to *PHYC*) in *Oryza sativa*, four *PHY* genes (*PHYP1*, *PHYP2*, *PHYN*, and *PHYO*) in *Pinus*, and three *PHY* genes (*PHYP*, *PHYN*, and *PHYO*) in *Ginkgo* (Bae and Choi 2008).

Since their initial discovery in 1959 (Butler et al. 1959), studies of several species have revealed that phytochromes control physiological responses from seed germination (Dechaine et al. 2009; Oh et al. 2009) to flowering (Andres et al. 2009; Brock et al. 2010). These responses also include hypocotyl elongation (Yang et al. 2009; Kunihiro et al. 2010) and flavonoid (Husaineid et al. 2007; Carvalho et al. 2010) and carotenoid (Schofield and Paliyath 2005; Toledo-Ortiz et al. 2010a) synthesis. Nowadays, many of these studies have elucidated the molecular and biochemical mechanisms involved in the signaling pathways of phytochrome action (Kidokoro et al. 2009; Jang et al. 2010; Li et al. 2010; Toledo-Ortiz et al. 2010b; Jang et al. 2011).

Briefly, phytochromes are ∼120 kDa peptides (called apoprotein) with a covalently linked linear tetrapyrrole bilin