ABSTRACT

TISSUE- AND ORGAN-SPECIFIC PHYTOCHROME-MEDIATED RESPONSES IN ARABIDOPSIS THALIANA

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The red/far-red light-absorbing phytochrome photoreceptor family regulates numerous responses throughout the life cycle of Arabidopsis thaliana. Despite the discovery of individual and redundant phytochrome functions through mutational analyses, conclusive reports on distinct sites of photoperception, and the mechanisms by which localized pools of phytochromes act at the molecular level in mediating tissue- and organ-specific responses are limited. The objectives of this thesis research are to identify sites of phytochrome photoperception in Arabidopsis, correlate them with the regulation of tissue- and organ-specific responses and recognize candidate downstream target genes that define the molecular bases of such responses. To address these objectives, a mammalian gene encoding an enzyme capable of reduction of functional phytochromes was expressed in a tissue-specific manner in transgenic Arabidopsis plants. Transgenic lines were probed for perturbed phytochrome-mediated responses under blue, red and farred illumination and comparative phenotypic and photobiological analyses of transgenic lines with constitutive, mesophyll- and meristem-specific phytochrome inactivation revealed distinct functions of localized pools of phytochromes. Mesophyll-localized phyA was found to exert a dominant role on hypocotyl inhibition, whereas hypocotyllocalized phyA was implicated in regulation of hypocotyl elongation in the absence of the inhibitory action of mesophyll-localized phyA under far-red light. Through comparative microarray-based gene expression profiling of transgenic Arabidopsis lines with constitutive and mesophyll-specific phytochrome inactivation and subsequent phenotypic characterization of mutants, this study also identified two proteins, a GNAT family protein and a caldesmon-related protein, as putative signaling intermediates in regulating phyA-mediated hypocotyl development under far-red light. Furthermore, phytochromedependent sucrose-stimulated anthocyanin accumulation was distinctively altered in transgenic lines with mesophyll-specific phytochrome inactivation. The analysis of anthocyanin pigmentation responses confirmed a functional role for mesophyll-localized phyA in regulating anthocyanin accumulation in far-red light and its contribution in blue light. Individual phytochrome isoforms were recognized to have divergent roles in anthocyanin accumulation under red light; phyA through phyD exhibit inductive roles and phyE functions as a novel suppressor of anthocyanin accumulation. Additionally, metabolic inactivation of the phytochrome chromophore in roots suggested that rootlocalized phytochrome and/or the phytochrome chromophore is vital for the photoregulation of root development and confers sensitivity to jasmonic acid. Thus, conclusive evidence from this study indicates that the analyses of spatially isolated pools of phytochromes is an effective tool for providing novel insight into the complex signaling pathways controlled by phytochromes.