Modulations of visible light irradiance effects the photosynthetic phenotype in UV-B exposed *Arabidopsis thaliana*

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Abstract

Photosynthesis is dependent upon energy provided by visible light from the electromagnetic spectrum. While such wavelengths of light are vital for resource assimilation to take place, we now also understand that other wavelengths of light may likely alter a plant's photosynthetic capability, including the ultraviolet (UV) radiation spectrum. The ultraviolet spectrum includes UV-A (315nm-400nm) and UV-B radiation (280nm-315nm). UV-B light has been of particular interest in recent years as changes in the ozone has resulted in increased UV-B radiation levels reaching the Earth's surface. Such scientific interest has resulted in many subsequent studies trying to understand how plants protect themselves against this powerful waveband. UV-B response in plants has been linked to both physiological and molecular changes in plants. That could be manipulated to protect plants against pathogens and increase crop yields. The quite recent discovery of the UV-B specific photoreceptor UVR8 showed how plants to respond to UV-B. A molecular pathway has begun to take shape for UVR8, with interactions with the transcription factors COP1 and HY5 necessary for activation. What is less understood are the subsequent interactions genes have with UVR8, to cause responses such as flavonoid accumulation and photosynthetic competency.

After previous research showed an increase in photosynthetic rate in lettuce in response to UV-B radiation this study aimed to find the photosynthetic response of *Arabidopsis thaliana* and possibly re-create the increase. To do this the photosynthetic rate was studied under various PAR levels alongside UV-B exposure to characterise the photosynthetic response. The accumulation of photo-protective compounds was also studied to see if their accumulation affected photosynthetic responses. Three different lines were studied; *Columbia-0, Landsberg erecta* and *uvr8-1*. The *uvr8-1* plants provided information on whether UVR8 is necessary for photosynthetic competency in Arabidopsis. qPCR studies of genes linked to the UVR8 pathway were also considered for their role in photosynthetic competency. The results in this thesis will show that manipulations of PAR, changes the UV-B photosynthetic response and that UVR8 is necessary for photosynthetic competency. ELIP1 and SIG5 are not mediated by UVR8 for photosynthetic competency. ELIP1 and SIG5 are possibly involved in UVR8 mediated accumulation of photo-protective compounds.

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Abbreviations

A_{max}	net photosynthetic rate
BLRP	blue light responsive promoter
bp	base pairs
CFCs	chlorofluorocarbons
CHI	CHALCONE ISOMERASE
CHS	CHALCONE SYNTHASE
Col-0	*Columbia-0*
COP1	CONSTITUTIVELY PHOTOMORPHOGENIC 1
CP12	CHLOROPLAST PROTEIN 12
CP12-1	CHLOROPLAST PROTEIN 12-1
CP12-2	CHLOROPLAST PROTEIN 12-2
CP12-3	CHLOROPLAST PROTEIN 12-3
CRY	Cryptochrome
cry1	cryptochrome1
cry2	cryptochrome2
DAS	Days after sowing
ELIP1	EARLY LIGHT-INDUCIBLE PROTEIN 1
ELIP2	EARLY LIGHT-INDUCIBLE PROTEIN 2
FAD	Flavin Adenine Dinucleotide
FLS	FLAVONOL SYNTHASE
FMN	Flavin Mononucleotide
FR	far-red light
GADPH	glyceraldehyde-3-phosphate
HY5	ELONGATED HYPOCOTYL 5
HYH	HY5 HOMOLOG
IRGA	Infra-red gas analyser
Ler	*Landsberg erecta*
LOV	light, oxygen, voltage
MAPK	mitogen-activated protein kinases
MT	Metal halides
MTHF	methenyltetrahydrofolate
MYB111	MYB DOMAIN PROTEIN 111
MYB12	MYB DOMAIN PROTEIN 12
NBI	nitrogen balance index
nm	Nanometers
PAR	Photosynthetically active radiation
PCR	polymerase chain reaction
PHR1	PHOTOLYASE 1
PHY	Phytochrome
PHYA	phytochrome A
PHYB	phytochrome B
PHYE	phytochrome E

PKR	Phosphoribulokinase
PSII	photosystem II
qPCR	quantitative PCR
R	red light
RFR	red: far-red light
ROS	reactive oxygen species
RUP1	REPRESSOR OF UV-B PHOTOMORPHOGENESIS 1
RUP2	REPRESSOR OF UV-B PHOTOMORPHOGENESIS 2
SE	Standard error
SIG5	SIGMA FACTOR 5
TRP	Tryptophan
UV	Ultraviolet
UV-A	Ultraviolet-A
UV-B	Ultraviolet-B
UV_{BE}	Biologically effective UV
UV-C	Ultraviolet-C
UVR3	UV REPAIR DEFECTIVE 3
UVR8	UV RESISTANCE LOCUS 8
VOC	volatile organic compounds
WFT	White fluorescent tubes
WL	White light
WUE	water use efficiency
ZTL	zeitlupes