Photoreceptor cross-talk in UV-B photomorphogenesis in tomato (*Solanum lycopersicum)*: Screening through phytochrome and cryptochrome mutants

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Abstract

Plant photoreceptors detect changes in the light environment and induce differential gene expression, resulting in the appropriate physiological and morphological responses. Under full sunlight, phytochromes, cryptochromes and the UV-B photoreceptor, UVR8 (UV-B RESISTANCE LOCUS 8), destabilize PHYTOCHROME INTERACTING FACTORS (PIFs) to inhibit elongation. PIFs are transcriptions factors that inhibit light-regulated genes, including auxin-related genes involved in cell elongation. In the shaded environment, the reduction in the spectral composition detected by the photoreceptors results in the activation of elongation and PIF activity. However, recent studies have shown that low levels of UV-B can still inhibit the elongation under shade.

Most photobiology studies that investigated plant responses to shade have concentrated on the model species, *Arabidopsis thaliana*. In contrast, *Solanum lycopersicum* (tomato) is another model system, but few studies have investigated plant responses to shade in tomato due to its sympodial architecture and presence of internodes which *A. thaliana* lacks. In this study, phytochrome and cryptochrome tomato mutants were exposed to low levels of UV-B under photosynthetically active radiation (PAR) as background light to investigate the possible cross-talk between these photoreceptors and the UV-B photoreceptor of tomato in regulating hypocotyl or internode elongation. Out of all the multiple phytochrome and one cryptochrome mutants, *phyAphyB2* mutant exhibited an impaired UV-B inhibition of internode elongation after three days of UV-B treatment. End-point PCR on the gene expression of PIF4 together with two UV-B responsive genes and genes involved in the catabolism of active gibberellin could not explain the impaired response of *phyAphyB2*. Nevertheless, physiological measurements indicate that phyA and phyB2 of tomato may be acting redundantly in mediating the UV-B induced inhibition of internode.

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Abbreviations

APA	Active binding domain of PHYA
APB	Active binding domain of PHYB
au	*aurea*
B	Blue light
CHS	Chalcone synthase
COP	CONSTITUTIVE PHOTOMORPHOGENIC 1
CRY	Cryptochrome protein
DET	DEETIOLATED
ein	elongated internode; *Brassica phyB* mutant
EOD-FR	End-of-day-far-red
EODT-PAR	End-of-day-treatment-PAR
EODT-UV	End-of-day-treatment-UVB
FAD	Flavin adenine dinucleotide
FHL	FAR-RED ELONGATED HYPOCOTYL LIKE
FR	Far-red light
fri	far-red insensitive; tomato *phyA* mutant
FUS	FUSCA
G	Green light
GA	Gibberellic acid
Ga2ox2	GIBBERELLIC ACID 2 OXIDASES 2
HFR1	HYPOCOTYL IN FAR RED 1
HIR	High irradiance response
HY5	LONG HYPOCOTYL 5
HYH	HY5 HOMOLOG

JA	Jasmonic acid
LeHY5	Tomato LONG HYPOCOTYL 5 gene
LFR	Low fluence response
lh	long hypocotyl
MM	Money maker
nm	Nanometer
PAR	Photosynthetically active radiation
Pfr	Active form of phytochrome capable of absorbing FR light
PHY	Phytochromes
PHYA, PHYB	Phytochrome A, phytochrome B, etc. apoprotein
PHYA, PHYB	Phytochrome A, phytochrome B, etc. gene
phyA, phyB	Phytochrome A, phytochrome B, etc. holoprotein
phyA, phyB	Phytochrome A, phytochrome B, etc. mutant
PIF	PHYTOCHROME INTERACTING FACTOR
Pr	Inactive form of phytochrome capable of absorbing R light
R	Red light
RCC1	Regulator of chromatin condensation 1
SAM	Shoot apical meristem
SAR	Shade avoidance response
sav3-2	mutant with a defect in the TAA1 pathway
FH1	FAR-RED ELONGATED HYPOCOTYL 1
SlPIF	Solanum lycopersicum PHYTOCHROME INTERACTING FACTOR
SPA	SUPRESSOR OF PHYTOCHROME A
TAA1	Tryptophan aminotransferase of *Arabidopsis* 1
tri	temporary insensitive; tomato *phyB1* mutant

Trp	Tryptophan
UV	Ultraviolet light
UVR8	UV-B RESISTANCE LOCUS 8
VLFR	Very low fluence response
WL	White light
WT	Wild-type tomato