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

A thesis presented in partial fulfilment of the requirements for the degree of

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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 transcription 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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Table of Contents

Abstract i
Acknowledgements iii
Table of Contents vi
List of Figures xi
List of Tables xii
Abbreviations xiii

1.0 Introduction 1
   1.1 Light detected by plants 1
   1.2 Arabidopsis 2
      1.2.1 Phytochromes 3
         1.2.1.1 Types of phytochromes 4
         1.2.1.2 Phytochrome response modes 5
      1.2.2 Cryptochromes 6
      1.2.3 UVR8 7
   1.3 Light and plant development 8
      1.3.1 Stages of plant development and strategies under light limiting conditions 8
      1.3.2 Light Signals that activate the Shade Avoidance Responses 9
      1.3.3 Roles of phytochromes, cryptochromes and UVR8 in Shade Avoidance 11
         1.3.3.1 Phytochromes mediate responses to low R:FR 11
         1.3.3.2 Cryptochromes and phytochromes induce shade avoidance elongation response under low B light 12
         1.3.3.3 UV-B inhibit growth response in shade 13
      1.3.4 Cost of Shade Avoidance Response 13
1.3.5 Molecular mechanism of photomorphogenesis and shade avoidance response

1.4 Significance of UV-B studies

1.4.1 Ozone depletion motivated UV-B studies

1.4.2 UV-B provide photoprotection and defence

1.5 Tomato as another model system

1.5.1 Why study tomato plant responses under UV-B?

1.5.1.1 Tomato: Economic importance

1.5.1.2 Tomato architecture: plant model for shade avoidance

1.5.2 Photoreceptors of Tomato

1.5.2.1 Characterization of tomato phytochromes

1.5.2.1.1 Tomato phytochrome A (far-red insensitive, *fri*)

1.5.2.1.2 Tomato phytochrome B1 (temporarily red light insensitive, *tri*) and phytochrome B2

1.5.2.1.3 Roles of phytochrome A, B1, B2 in shade avoidance response

1.5.2.1.4 Cryptochromes

1.5.2.1.5 UV-B photoreceptor

1.6 Project Aims

1.6.1 Questions to be answered

1.6.2 Hypothesis

2.0 Materials and Methods

2.1 Plant Material and growing conditions

2.2 Transplanting and Allocation

2.3 Light Treatments

2.4 Measurements
2.5 End-Point PCR

2.5.1 Sample preparation and RNA extraction 35

2.5.2 Genomic DNA extraction 35

2.5.3 DNAseI treatment of RNA samples and cDNA synthesis 37

2.6 General functions of genes of interests 39

2.6.1 Tomato PHYTOCHROME INTERACTING FACTOR 4 (SlPIF4) 39

2.6.2 Tomato long hypocotyl 5 (LeHY5) 41

2.6.3 Tomato GIBBERELLINE 2 OXIDASE 2 (Ga2ox2) 41

2.6.4 Tomato Chalcone Synthase 1 (CHS1) 42

3.0 Results 43

3.1 Seed germination 43

3.2 Screening using low fluence UV-B 44

3.3 Increase in WT hypocotyl elongation rate is not due to shading 46

3.4 Low fluence UV-B is unable to inhibit the internode of phyAphyB2 48

3.4.1 UV-B inhibition responses of the hypocotyl and internode may be age-dependent 50

3.5 UV-B treatment is more effective in inhibiting hypocotyl when applied in the morning 52

3.6 PCR troubleshooting using housekeeping genes: TUBULIN and ACTIN 53

3.6.1 TUBULIN primers are not annealing to tomato tubulin 53

3.6.2 ACTIN primers are more consistent in amplifying tomato ACTIN 57

3.7 UV-B increases expression of light regulated genes of UV-B treated tomatoes 58

4.0 Discussion 60

4.1 Germination of tomato phytochrome and cryptochrome mutants 60
4.2 Increase in WT hypocotyl elongation may be due to UV-B entrainment on the plant’s circadian clock

4.3 Phytochrome A and B2 activity may be involved interacting with the UV-B photoreceptor of tomatoes in regulating internode elongation under UV-B

4.4 Tomato LONG HYPOCOTYL 5 (LeHY5) and Chalcone Synthase 1 (CHS1) as UV-B-responsive marker gene

4.5 Dose-dependent upregulation of tomato SIP1F4 after four hours of UV-B.

4.6 Gibberellic 2 oxidase2 (Ga2ox2) upregulation typical response to UV-B inhibition of cell elongation

5.0 Conclusion

Appendices

APPENDIX A: Table 1: RNA concentrations of 16 samples measured using Nanodrop.

APPENDIX B: Table 1: Primers used in endpoint PCR.

<table>
<thead>
<tr>
<th>Table 2: Annealing temperatures used for amplification of target genes during PCR.</th>
</tr>
</thead>
</table>

APPENDIX C: Table 1: PCR program used to amplify target genes.

APPENDIX D: Figure 1: Summary of PCR optimization.

References
List of Figures

Figure 1.1: Electromagnetic spectrum detected by plant photoreceptors 3
Figure 1.2: Photoequilibrium of the inactive (Pr) and active (Pfr) form of phytochromes 4
Figure 1.3: Photomorphogenic response of plants under high R:FR ratio inhibit growth and low R:FR induce stem elongation 9
Figure 1.4: Proposed model illustrating molecular interaction between phytochromes and UVR8 in environments where there are no competitions and presence of neighbouring plant competitors. 15
Figure 1.5: Summary of photoreceptor signaling under full sunlight. 18
Figure 1.6: Architectural difference between wild-type Arabidopsis and tomato. 23
Figure 2.1: Fluorescent tubes light spectrum measured using the Optronics 756 spectroradiometer. 30
Figure 2.2: Plants allocated in two conditions: crowded (3 days after treatment) and non-crowded condition (2 days before treatment) 31
Figure 2.3: First treatment schedule. 32
Figure 2.4: Second treatment schedule. 33
Figure 2.5: Developmental stage of WT (and other mutants) at 14 DAS on the day of treatment. 34
Figure 3.1: Developmental stage at which plants were treated. Plants (13-15 DAS) treated had two true leaves emerging. (Image above is 14 DAS WT under PAR light.) 43
Figure 3.2: Tomato wild-type, phytochrome and cryptochrome mutants’ relative hypocotyl and internode growth rate after treatment of PAR and PAR+UV-B for three days. 45
Figure 3.3: Hypocotyl and internode growth rate of WT exposed to two light conditions: PAR and PAR + UV-B for 3 days. 46

Figure 3.4: Relative hypocotyl and internode growth rate of phytochrome and cryptochrome mutants after exposure to low dose of UV-B for three days. 48

Figure 3.5: Percentage UV-B inhibition of internode elongation after 3 days of PAR + UV-B treatment. 49

Figure 3.6 Developmental check of hypocotyl and internode growth of WT, phyAphyB1, phyAphyB2 and cry1 of tomatoes throughout the experimental period. 50

Figure 3.7 End-of-day-treatment (EODT) experiment on wild-type tomatoes. 52

Figure 3.8 RNA quality smear test. 54

Figure 3.9 Block PCR products of DNAse treated and synthesized cDNA from all 16 samples together with gDNA of WT (grown under white light) as positive control and water as negative control. 55

Figure 3.10 PCR products using ACTIN primers and PP2AcS primers 56

Figure 3.11: Expression levels of light regulated genes in tomato. 58

List of Tables

Table 2.0: Summary of genotypes used in the PAR and PAR+UV-B experiments. 30

Table 2.1: RNA extracted from plants treated after 4 hours of initial UV-B treatment. 35

Table 2.2 Summary of light treatment experiments 37

Table 3.1: Tomato seeds sowing day and germination percentage 43

Table 3.2: Light regulated genes used in gene expression analysis. 58
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

SIPIF  Solanum lycopersicum PHYTOCHROME INTERACTING FACTOR

SPA  SUPPRESSOR OF PHYTOCHROME A

TAA1  Tryptophan aminotransferase of Arabidopsis 1

tri  temporary insensitive; tomato phyB1 mutant
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>Trp</td>
<td>Tryptophan</td>
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<tr>
<td>UV</td>
<td>Ultraviolet light</td>
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<td>UVR8</td>
<td>UV-B RESISTANCE LOCUS 8</td>
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<tr>
<td>VLFR</td>
<td>Very low fluence response</td>
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<td>WL</td>
<td>White light</td>
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<tr>
<td>WT</td>
<td>Wild-type tomato</td>
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