

# Studies on Molecular Mechanisms Underlying Photoperiodic Flowering Responses in Circadian Clock Mutant

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# **Abstract**

Many biological processes, including the control of flowering time, are regulated by the circadian clock. Although a number of clock-associated genes have been characterized in *Arabidopsis thaliana* (Arabidopsis), the complete molecular mechanisms of the circadian clock remain unclear. To find a novel component that controls the photoperiodic pathway via the circadian clock, I screened mutants that showed altered photoperiodic flowering.

In Part1, I report that CO-EXPRESSED WITH CLOCK GENES LHY AND CCA1 1 (CEC1) plays an important role in circadian clock function in Arabidopsis. Three genes, *CEC1*, *CEC2*, and *CEC3*, are co-expressed with the clock genes *LATE ELONGATED HYPOCOTYL (LHY)* and *CIRCADIAN CLOCK ASSOCIATED 1 (CCA1)*. The mutants, *cec1* and *cec2*, exhibited an early flowering phenotype under long-day (LD) and continuous-light (LL) conditions, possibly through an increase in *CONSTANS (CO)* and *FLOWERING LOCUS T (FT)* mRNA. In addition, rhythmic peaks of *GIGANTEA (GI)* expression were delayed in the *cec1* mutant plants, but the period length and amplitude of *GI* expression were not affected under LD and LL. These results suggest that CEC1 might contribute to the determination of circadian phases.

In Part2, to understand molecular mechanisms, underlying the photoperiodic flowering regulated by circadian clock, genetic screening for the Arabidopsis mutant that showed late flowering under LD or LL and early flowering under SD was performed. I named the mutant as *short day plant (sdp)* mutant.

## Abbreviations

Arabidopsis: *Arabidopsis thaliana*

bp: base pairs

CCA1: CIRCADIAN CLOCK ASSOCIATED 1

CDF1: CYCLING DOF FACTOR 1

CIB1: CRY2-interacting bHLH 1

CO: CONSTANS

COL: CONSTANS-LIKE 1

Col: Columbia

cDNA: complementary DNA

DNA: deoxyribonucleic acid

ELF3: EARLY FLOWERING 3

ELF4: EARLY FLOWERING 4

EMS: ethyl methanesulfonate

F<sub>1</sub>: first filial generation

F<sub>2</sub>: second filial generation



F<sub>3</sub>: third filial generation

FLC: FLOWERING LOCUS C

FT: FLOWERING LOCUS T

gDNA: genomic DNA

GI: GIGANTEA

Hd1: HEADING DATE 1

Hd3a: HEADING DATE 3a

LCL5: LHY-CCA1 LIKE5

LD: long day

*Ler*: Landsberg *erecta*

LHY: LATE ELONGATED HYPOCOTYL

LL: continuous light

LNK1: NIGHT LIGHT INDUCIBLE AND CLOCK-REGULATED GENES 1

LUX: LUX ARRHYTHMO

OOP1: OUT OF PHASE 1

OsGI: *Oryza sativa* GIGANTEA

PCR: polymerase chain reaction

PHYB: PHYTOCHROME B

PRR: PSEUDO-RESPONSE REGULATOR

RVE8: REVEILLE 8

q-RT-PCR: Quantitative reverse transcription PCR

RNA: ribonucleic acid

TOC1: TIMING OF CAB EXPRESSION 1

SD: short day

SDP: SHORT DAY PLANT

SSLP: simple sequence length polymorphism

SVP: SHORT VEGETATIVE PHASE

WT: wild-type

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