Phenotypic Variation in Circadian Near Isogenic Lines of *Arabidopsis thaliana*

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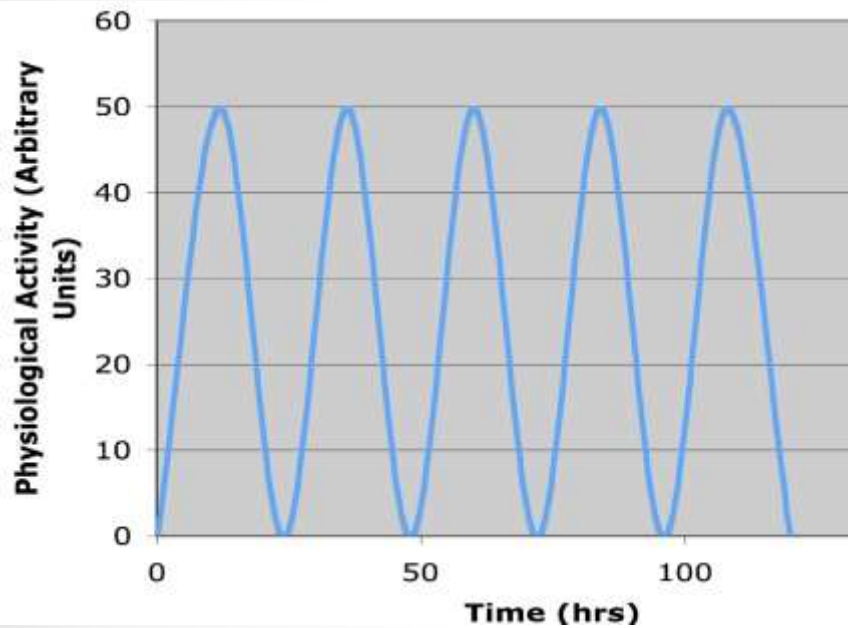
Circadian Rhythms



- The Earth rotates on its axis once every 24 hours
  - Providing predictable cycles of light and temperature
- Most organisms exhibit circadian rhythms
  - Circadian rhythms are endogenous repeating rhythms
  - Circadian rhythms are "set" by external cues
- Many physiological and behavioral characters are controlled by circadian rhythms
  - Best example in plants is photosynthesis

Arabidopsis thaliana: The Real-Live Plant

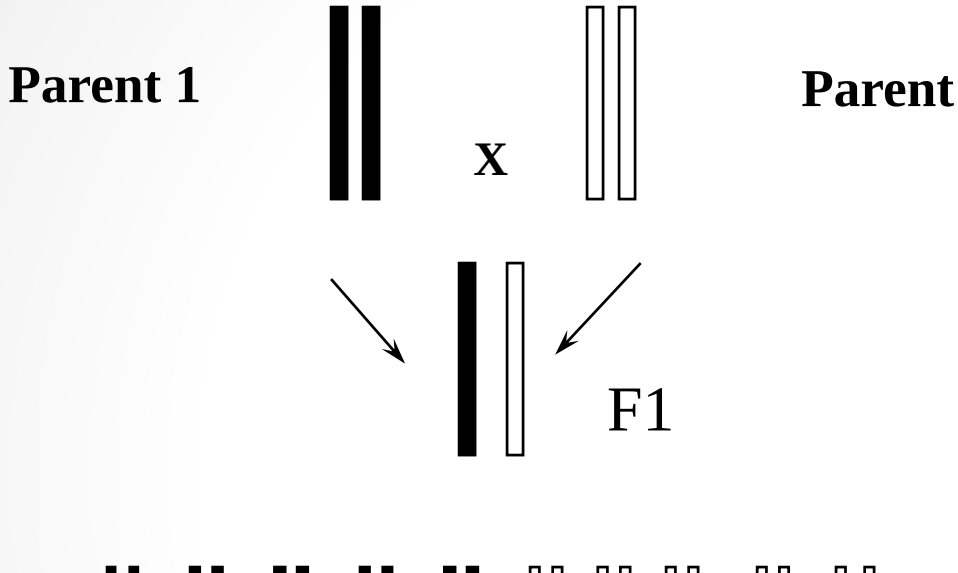
- Member of the mustard family
  - Related to cabbage, cauliflower, kohlrabi, broccoli, and kale

- Useful for environmental studies:
  - Primarily self-fertilizing
  - Naturally highly inbred families
    - Grow replicates of each genotype in each environment.
  - Short-lived annual
  - Fitness estimated from fruit number

Research Questions

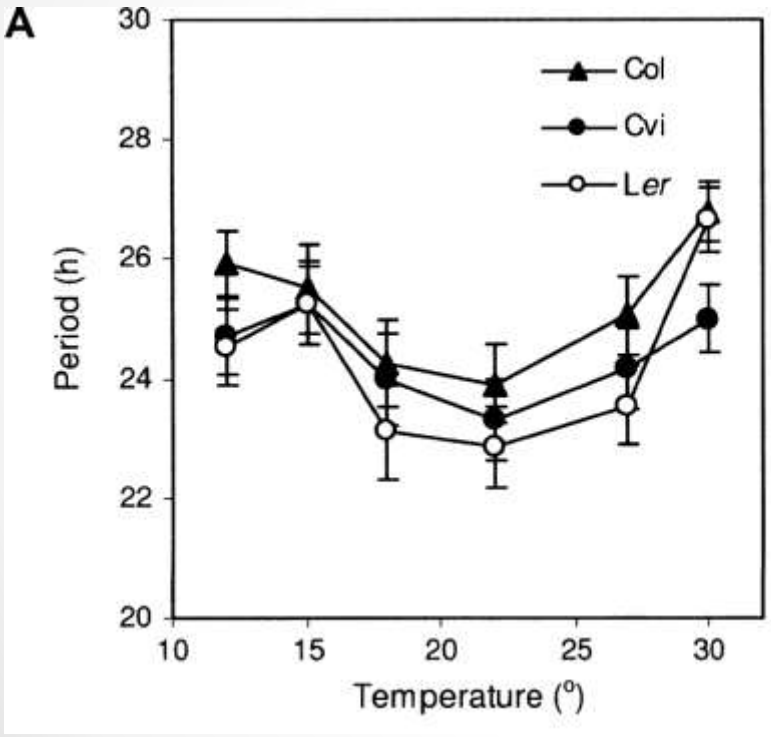
1. Do previously characterized circadian NILs show patterns in other non-circadian traits?
2. Can physiological parameters be measured at both the whole plant and leaf level?
3. Are any of the measured traits adaptive?

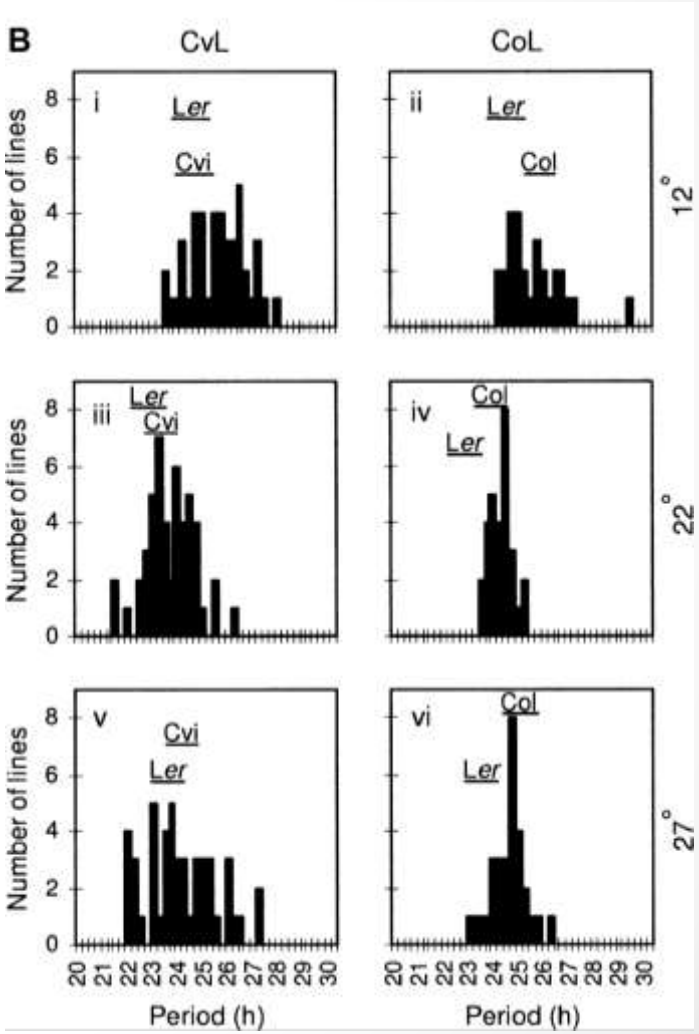
Recombinant Inbred Lines



- Each RIL is a novel combination of parental alleles

Temperature Compensation

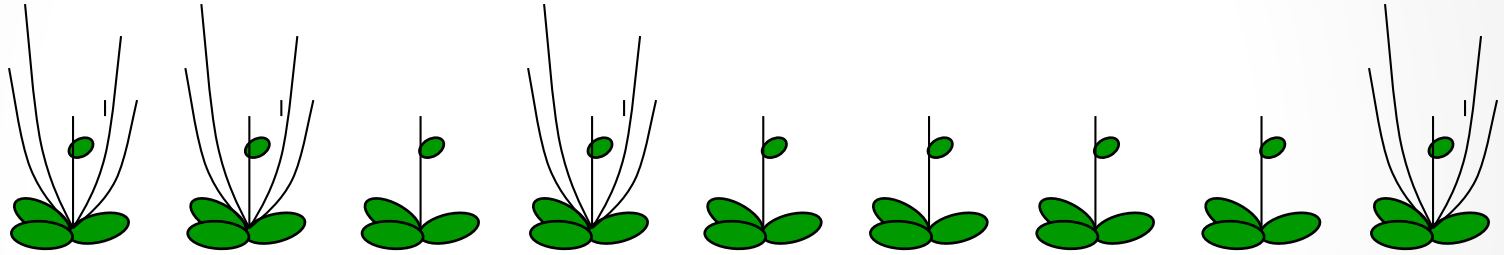




Edwards K D et al. Genetics 2005;170:387-400

QTL Mapping

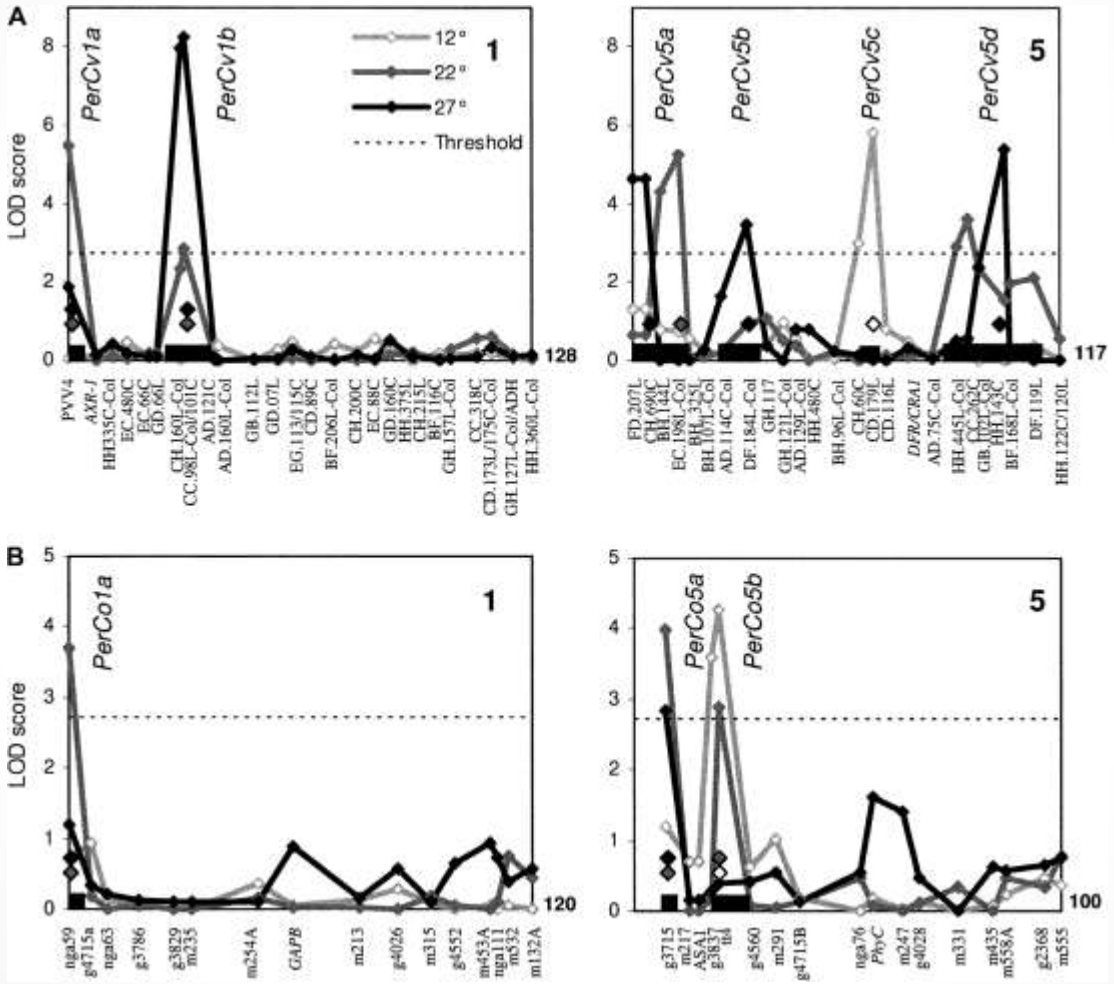
- QTL mapping tests for an association between a genetic marker state and phenotype



marker	M	M	m	M	m	m	m	m	M
QTL	Q	Q	q	Q	q	q	q	q	Q

M = Marker allele 1
m = Marker allele 2
Q = Allele for branching
q = Allele for fewer branches

QTL Mapping Results



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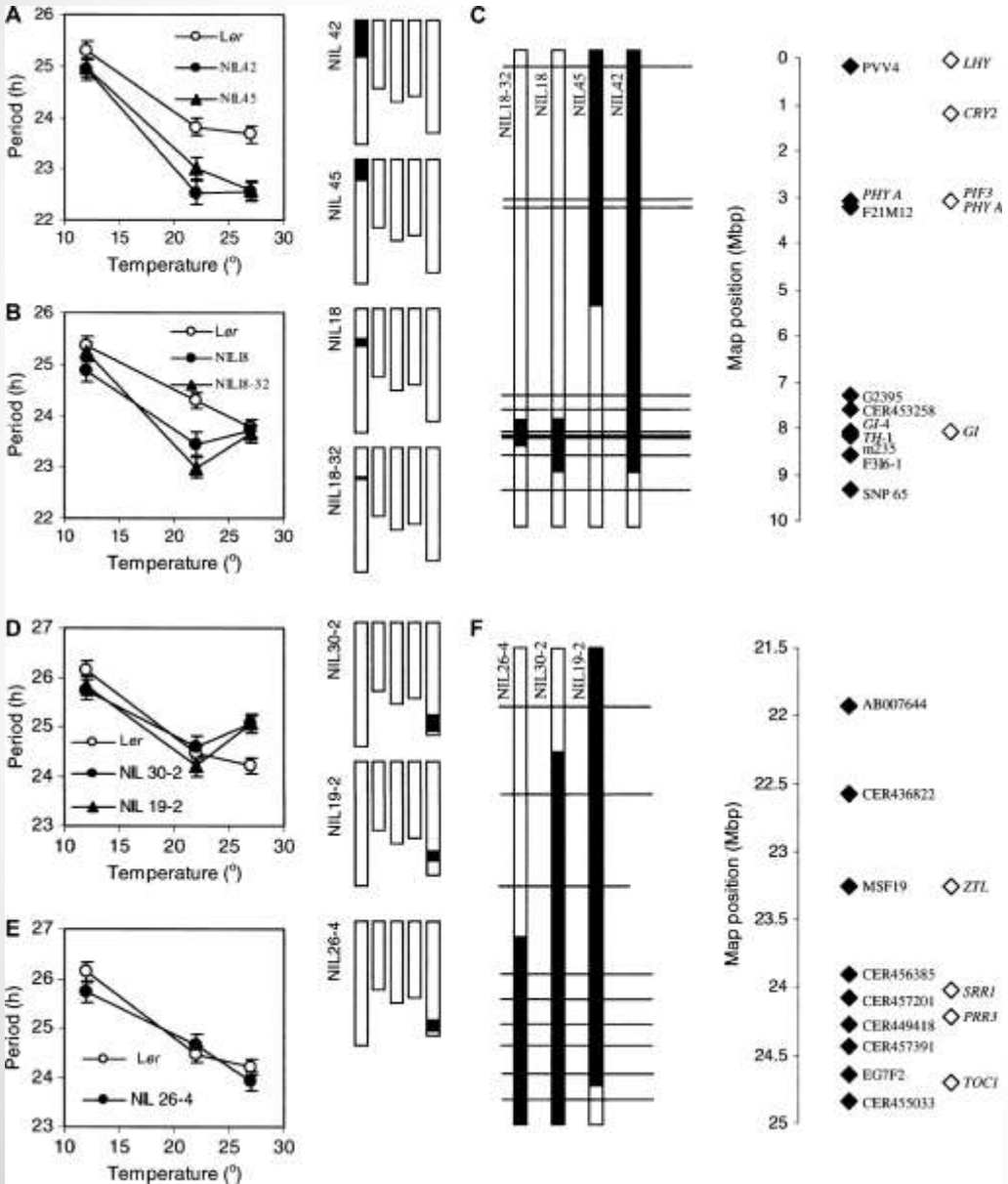
NILs test the effect of a single introgression



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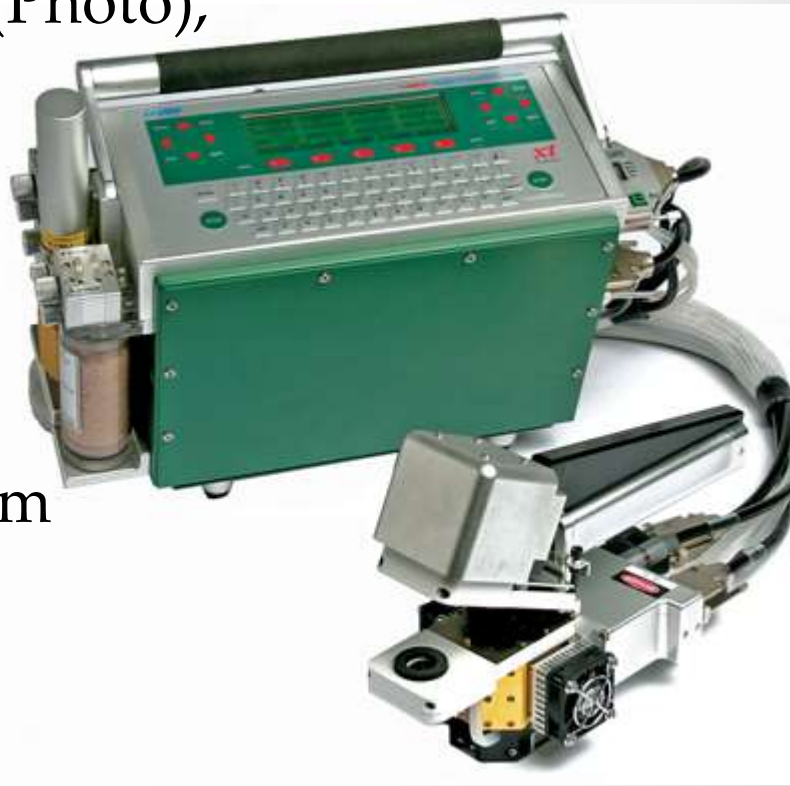
Greenhouse Project

- Genotypes: Cvi x Ler NILs
- 16 replicates of each NIL
  - Grew at warm temperature (from Edwards et al)
    - As a result we have NILs that are either short, WT, or long period
- Cold-treated seeds for 4 days
  - Measure Physiology traits
  - Days to Germination
  - Days to Flowering
  - Leaf number
  - Leaf size

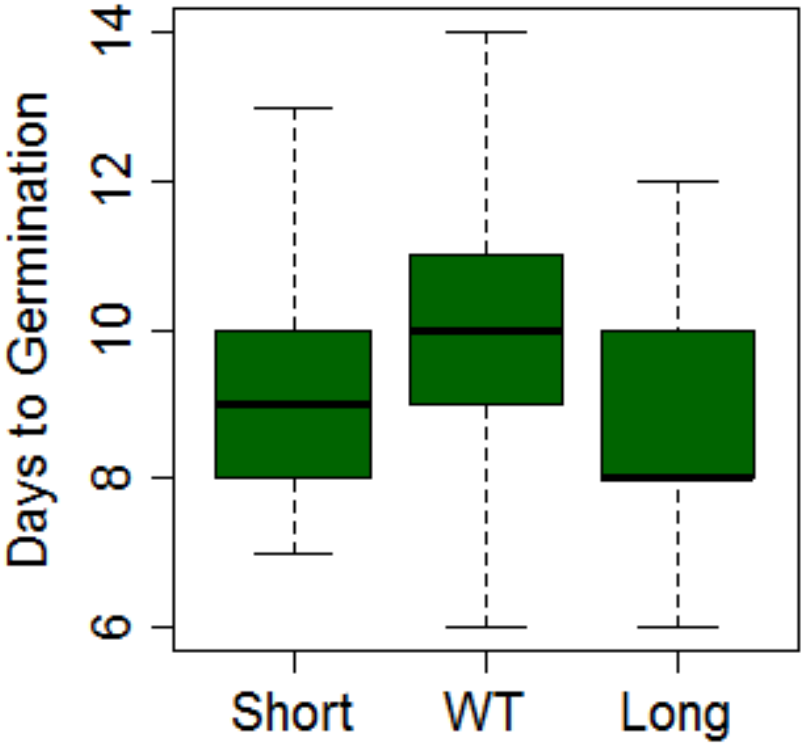
IRGA (infra-red gas analyzer) gas exchange system

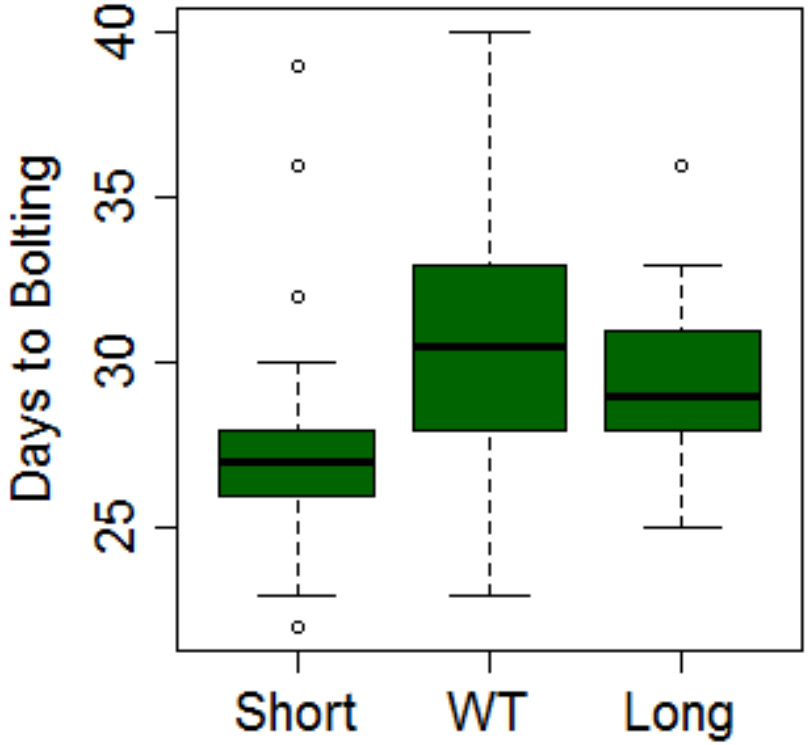
Parameters measured or calculated:

- photosynthetic carbon assimilation (Photo),
- stomatal conductance (Cond),
- intercellular CO_2 concentration (Ci),
- fluorescence (Fs),
- leaf transpiration,
- vapor pressure deficit calculated from measure leaf temperature (VpdL),
- measured air temperature (Tair),
- measured leaf temperature (Tleaf),

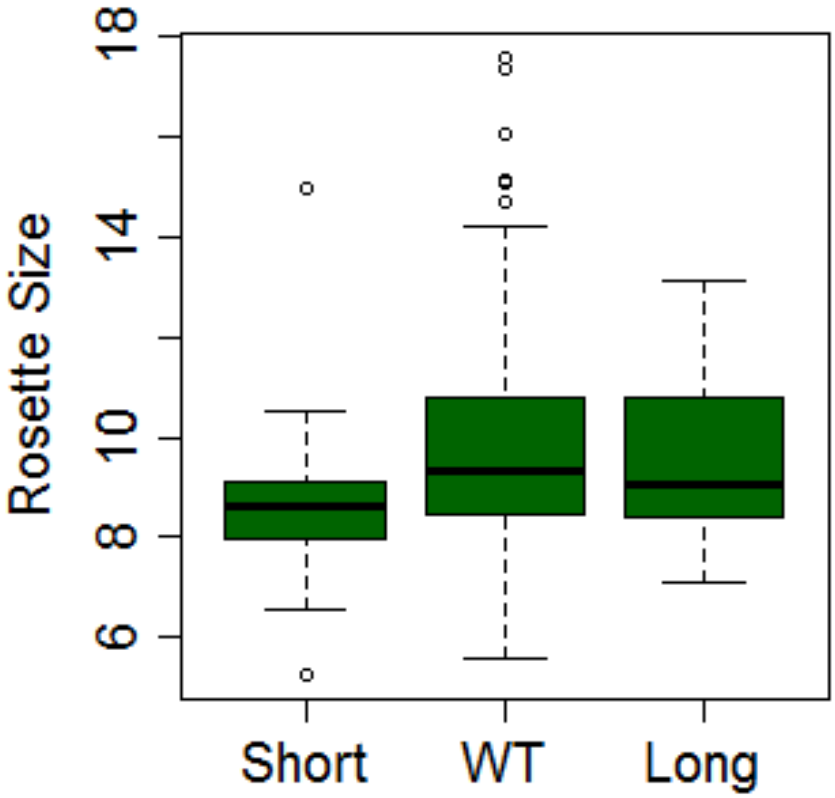


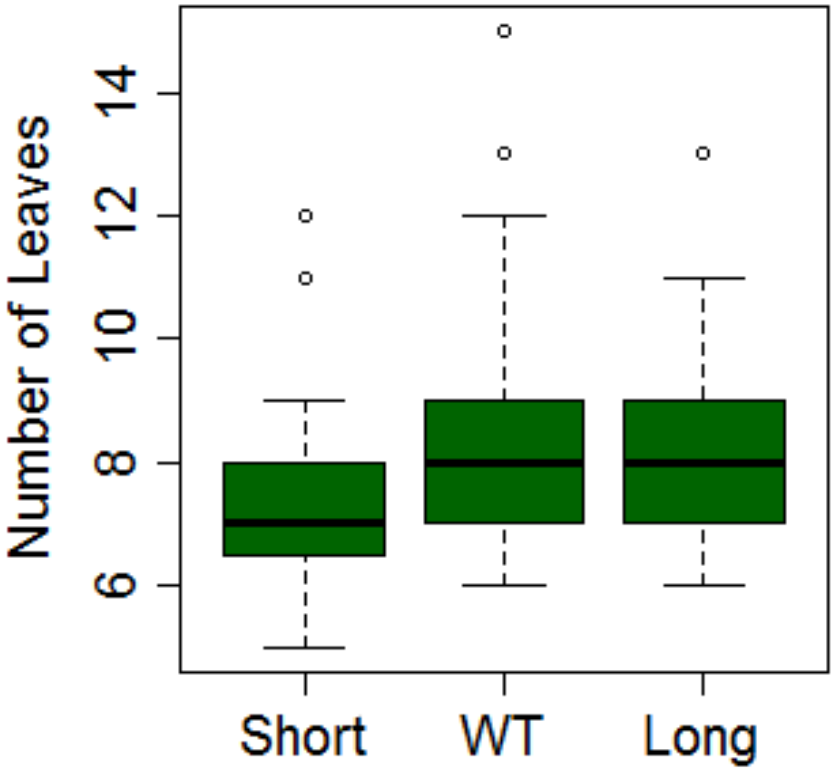
Days to Germination and Bolting Advanced in Short and Long Period NILs



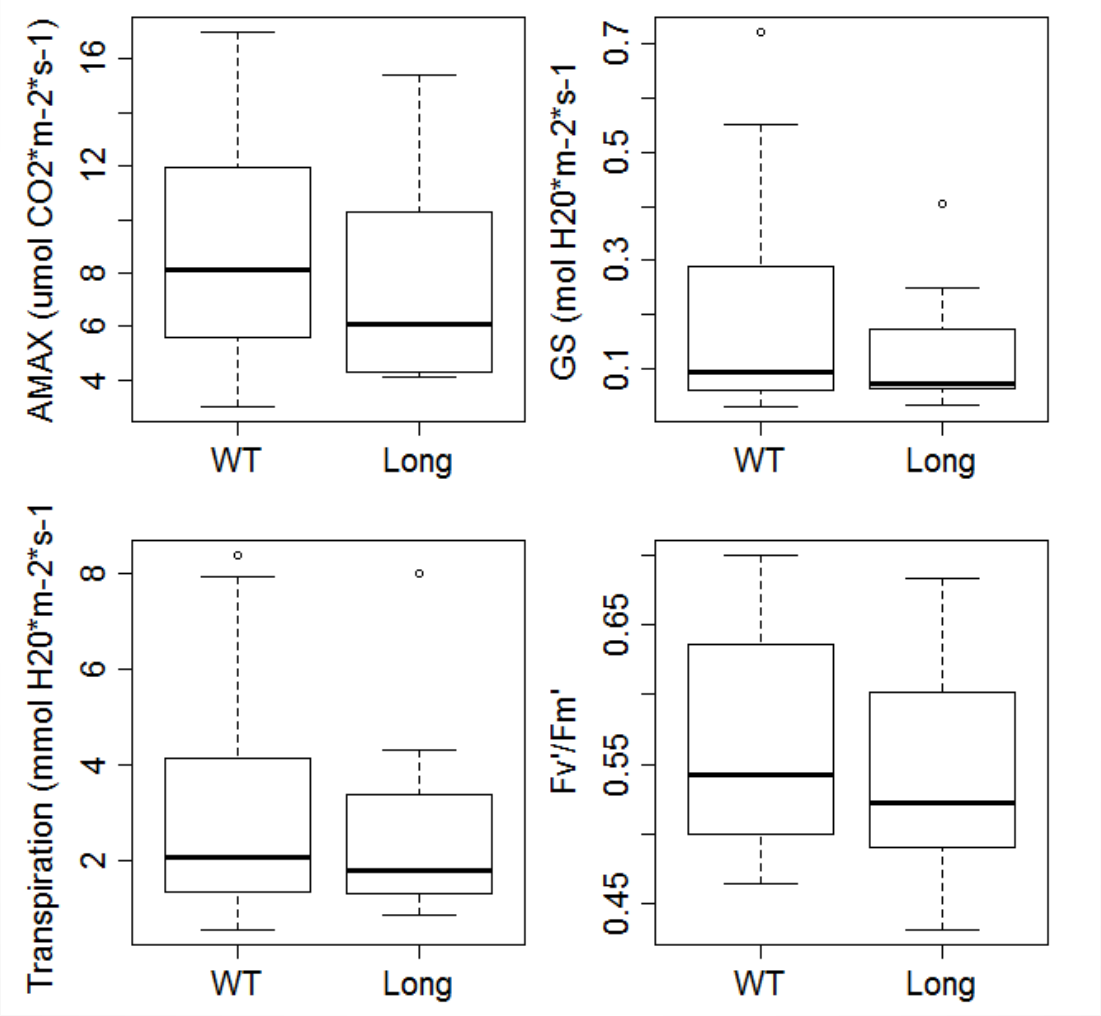


Short Period NILs Have Reduced Size and Leaf Number





Net photosynthesis and quantum yield tend to be higher in WT plants



Difficulties in Physiological Measurements

- Whole plant IRGA requires plants to be at an earlier developmental stage than other studies making it difficult to compare across experiments

- Soil respiration is confounded with plant measurements
  - Overcome by “capping soil” with plastic or clay

Circadian Clock is Adaptive

- Earth rotates every 24 hours providing predictable cycles of light and temperature
- WT and WT-like NILs have increased leaf number and size. These two traits are often positively correlated with fruit set.
- WT plants tended towards higher net photosythesis and more effiecient photosytem II activity.

Future Research

- Increase replication
  - Lead to better sampling of NILs and period classes

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