# The role of *Phytochrome A* in the heat stress response of *Arabidopsis thaliana*: Linkage or gene regulation?

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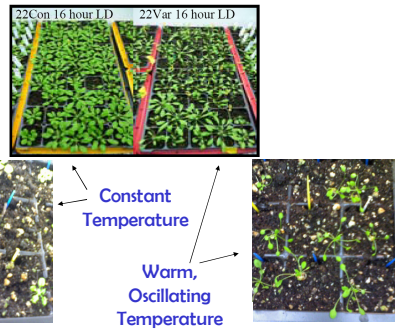
## Heat stress in *Arabidopsis thaliana*

Growth under warm, oscillating temperatures induces a 'shade-avoidance' type response.

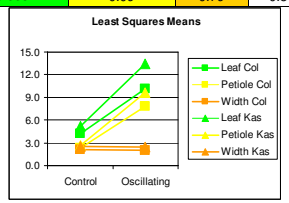



Plants grow longer thinner, leaves, similar to when they are grown in shade.

Is this response the same across different strains?

Early leaf length shows strain specific differences in the response to warm, oscillating temperatures

| | Leaf Length (mm) | Petiole Length (mm) | Width (mm) | 2→4 (days) |
|---|---|---|---|---|
| RSquare | 0.90 | 0.87 | 0.24 | 0.02 |
| Mean | 7.5 | 5.1 | 2.2 | 11.6 |
| N | 40 | 40 | 40 | 39 |
| TRT | <.0001* | <.0001* | 0.42 | 0.56 |
| strain | <.0001* | 0.0129* | 0.0041* | 0.44 |
| TRT*strain | 0.0097* | 0.09 | 0.79 | 0.81 |




p = < 0.05, ** p = < 0.001, ***p = < 0.0001

Strain x Treatment interactions indicate loci controlling the response to oscillating temperature may differ between strains.

## The Plants

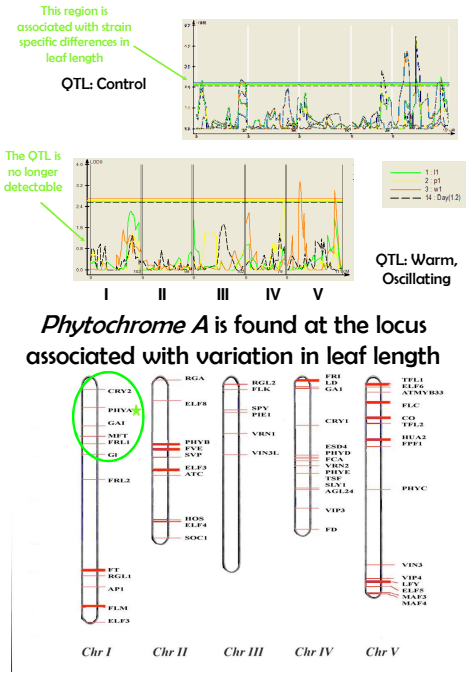
92 Kas-1 x Col-gl1 Recombinant Inbred Lines

Parental Lines:
**Kashmir** (A wild strain from the Himalayan region)
Requires vernalization (cold exposure prior to flowering)
**Columbia-gl1** (Derived from Columbia-1,a lab strain)
Does not require vernalization

Known to segregate for several growth and flowering genes such as *FRI, FLC, FLM, MAF2, CRY2,* and *HUA2*

BUT NOT FOR *Phytochrome A*, a far-red sensing gene.

QTL Maps also show that different loci are detected under warm, oscillating conditions!




*Phytochrome A* is found at the locus associated with variation in leaf length




## Why *Phytochrome A*?

The Phytochrome receptors are known to respond to far-red light and to heat.

Schmitt (2003) showed that *Phytochrome A* mediates the shade avoidance response in plants grown in far-red light.

Balasubramanian (2006) showed that high temperatures can induce flowering and that *Phytochrome A* mediates this response.

Warm, oscillating temperatures promote flowering in Kas-1, which normally requires verbalization, and causes Col-gl1 to flower sooner and with fewer leaves.

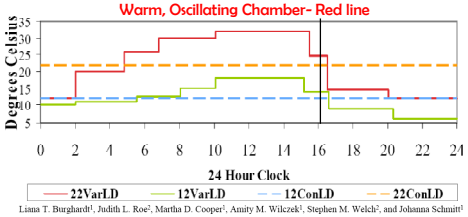
| | Leaf # * | Rosette Diameter (mm) * | 2→F (days) |
|---|---|---|---|
| RSquare | 0.54 | 0.52 | 0.38 |
| Mean | 10.3 | 31.8 | 40.5 |
| N | 24 | 24 | 23 |

| | Control | Oscillating |
|---|---|---|
| Columbia-*gl1* | 12.1 | 8.8 |
| | 24.8 | 36.9 |
| | 45.9 | 36.0 |
| Kashmir-1 | No Flower | 8.5 |
| | No Flower | 42.5 |
| | No Flower | 30.0 |

* At time of flowering

## The Treatments

Control Chamber- Orange line
Warm, Oscillating Chamber- Red line

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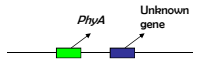
Plants were grown in Percival I-360 Incubators programmed to simulate summer field conditions in Norwich, UK, at the southern extreme of the normal range for summer growth of *A. thaliana*.
Both chambers have a mean temperature of 22° C.

## Linkage versus Regulation

*Phytochrome A* itself cannot be responsible for difference in how the two strains respond to he stress because the genes are identical.




**Linkage** - The difference in how the two strains respond to heat stress is caused by variation in a second gene located very close to the *PhyA* gene


**Regulation** - The difference in how the two str respond to heat stress is caused by variation in a nearby regulatory region associated with the *Ph* gene.

## Gene expression under warm, oscillating conditions

We currently growing Kas-1 and Col-gl under both control and under warm, oscillating conditions.

Expression of *Phytochrome A* will be quantified using RT-PCR.

Strain specific differences in *Phytochrome* expression across environments support regulatory variation as playing a role in t variation in the response to warm, oscillating temperatures.

If both strains show comparable changes gene expression across environments the regulatory variation cannot explain th variation in the response to warm, oscillating temperatures.