HotSol

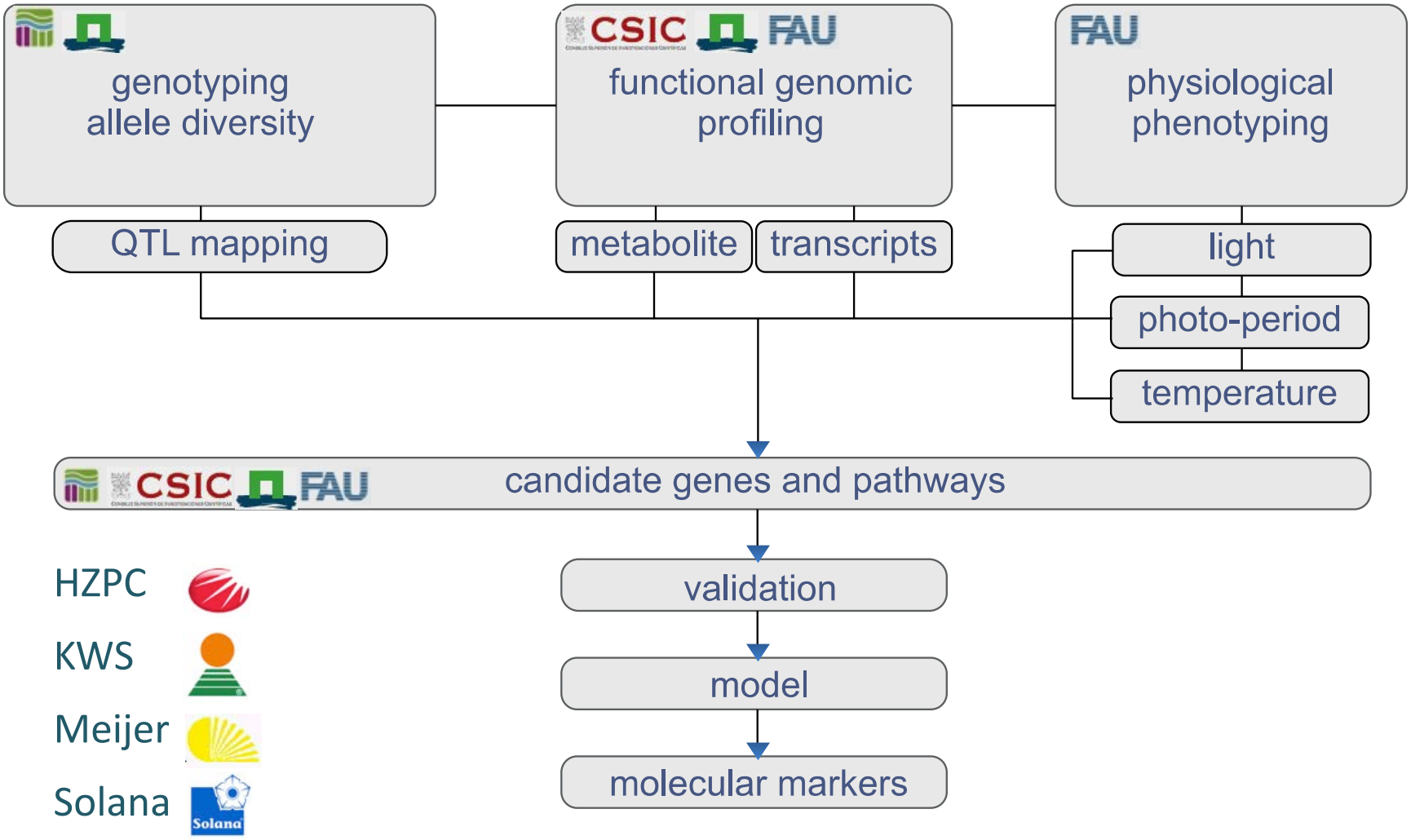
Christian Bachem, WUR, NL

WAGENINGEN UR
For quality of life

ERA-CAPS

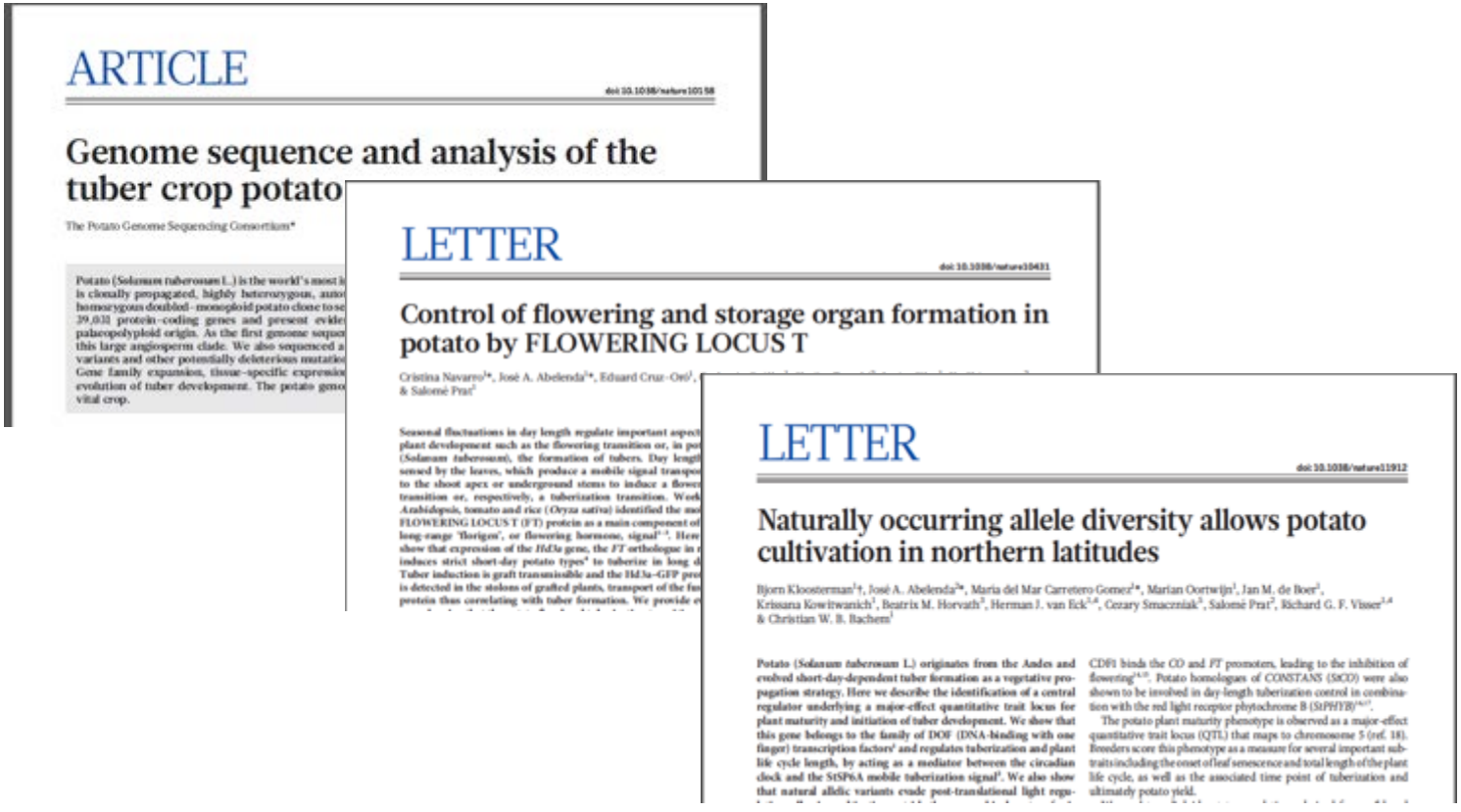
ERA-NET for Coordinating Action in Plant Sciences

Project structure



The Partnership

- The consortium has achieved breakthroughs in the understanding of tuber life cycle
- The consortium has developed new tools



ARTICLE

Genome sequence and analysis of the tuber crop potato

The Potato Genome Sequencing Consortium*

LETTER

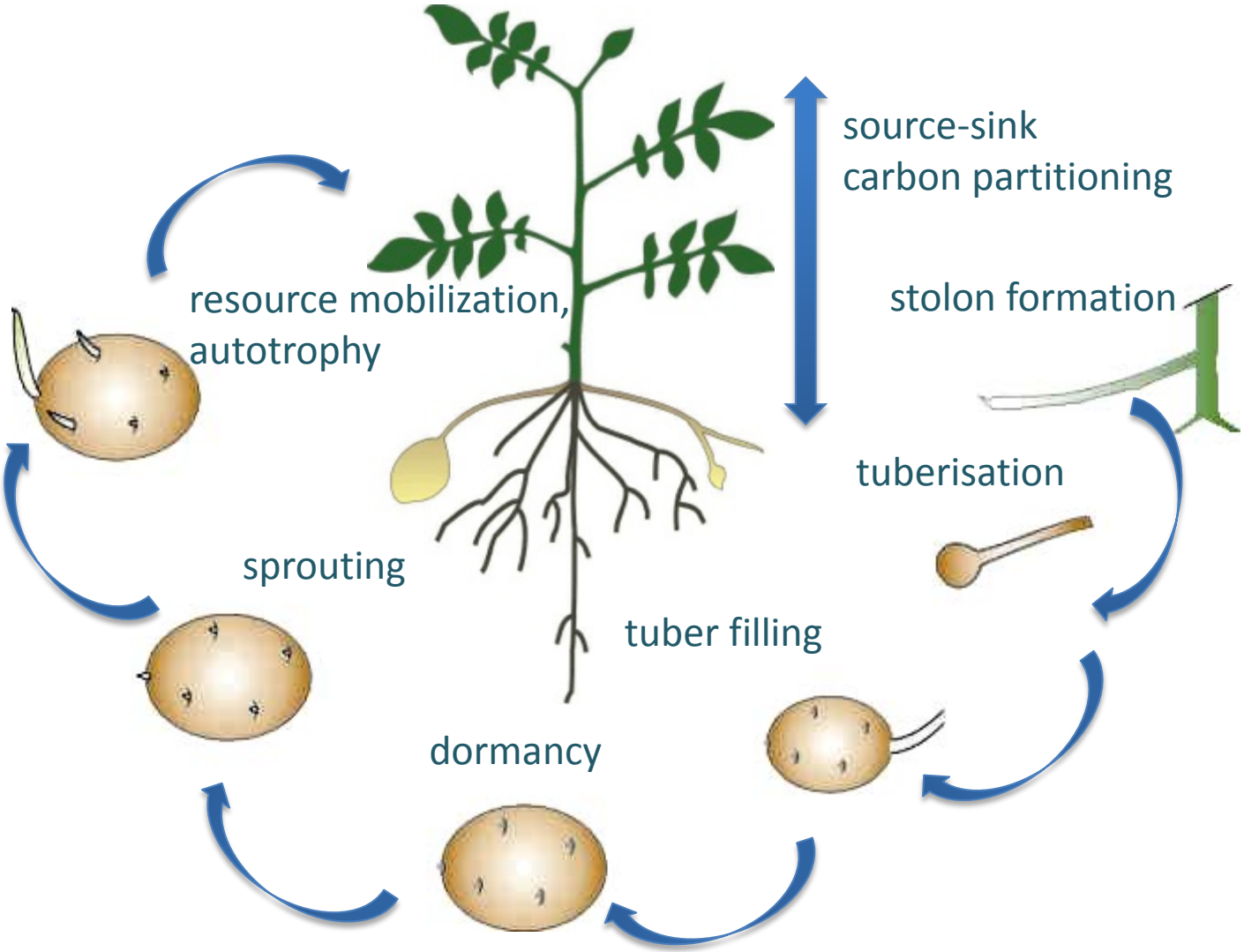
Control of flowering and storage organ formation in potato by FLOWERING LOCUS T

LETTER

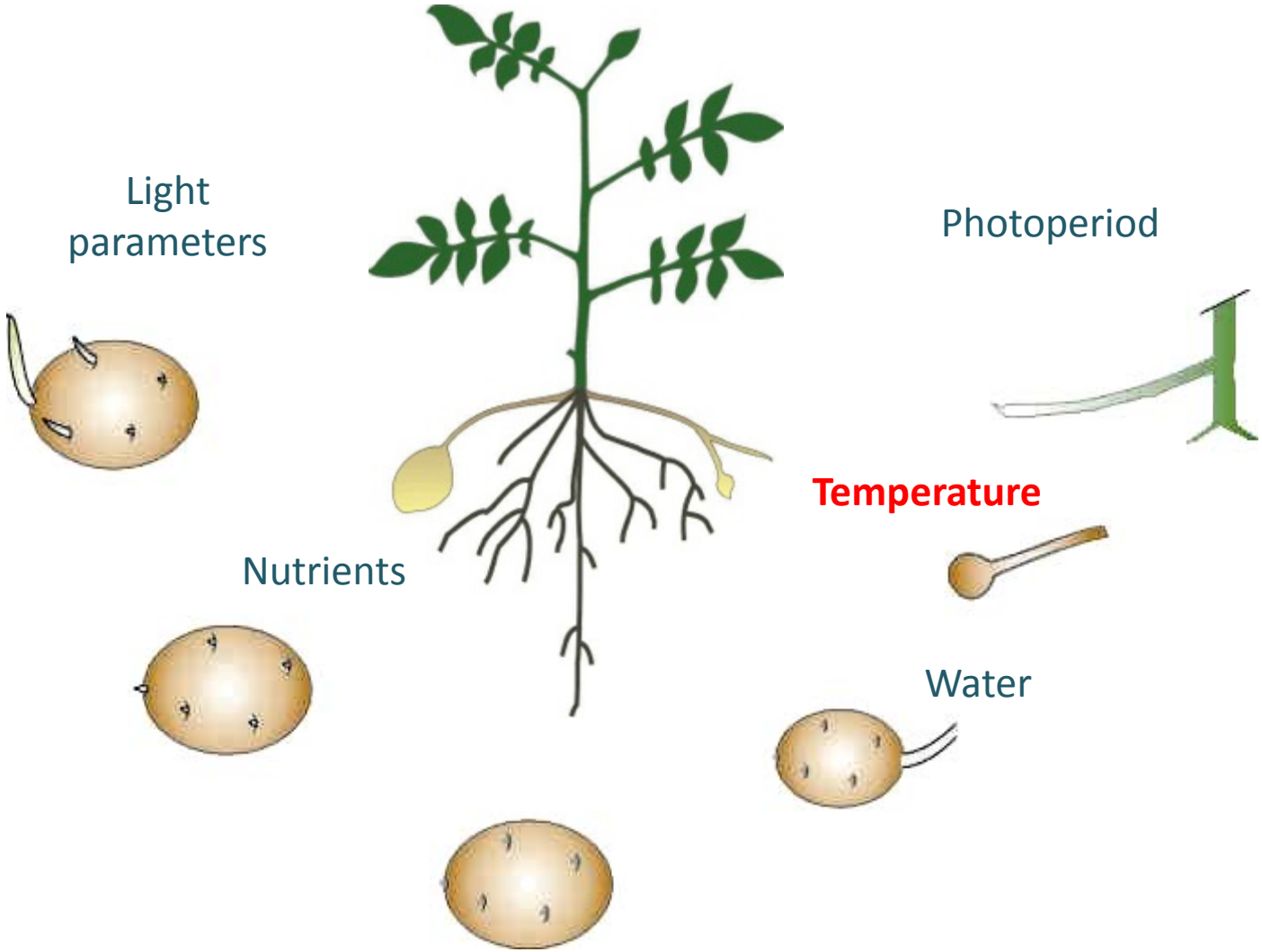
Naturally occurring allele diversity allows potato cultivation in northern latitudes

Björn Kloosterman[1]†, José A. Abelenda[2]*, María del Mar Carretero-Gomez[2]*, Marian Oortwijn[1], Jan M. de Boer[1], Krissana Kowitwanich[1], Beatrix M. Horvath[3], Herman J. van Eck[1,4], Cezary Smaczniak[3], Salomé Prat[2], Richard G. F. Visser[1,4] & Christian W. B. Bachem[1]

Potato tuber life-cycle



Environmental factors



The problem

- Potato is an increasingly important food crop
- Climate change is leading to higher temperatures
- Potato development is negatively affected by high temperature
- Tuber yield falls sharply above optimum temperatures
- There are also other temperature dependent quality issues

Temperature effects on tuberisation

Beginnender Durchwuchs an den Augen

Durchwuchs mit Knollen- & Sprossbildung

Durchwuchs mit Kindelbildung

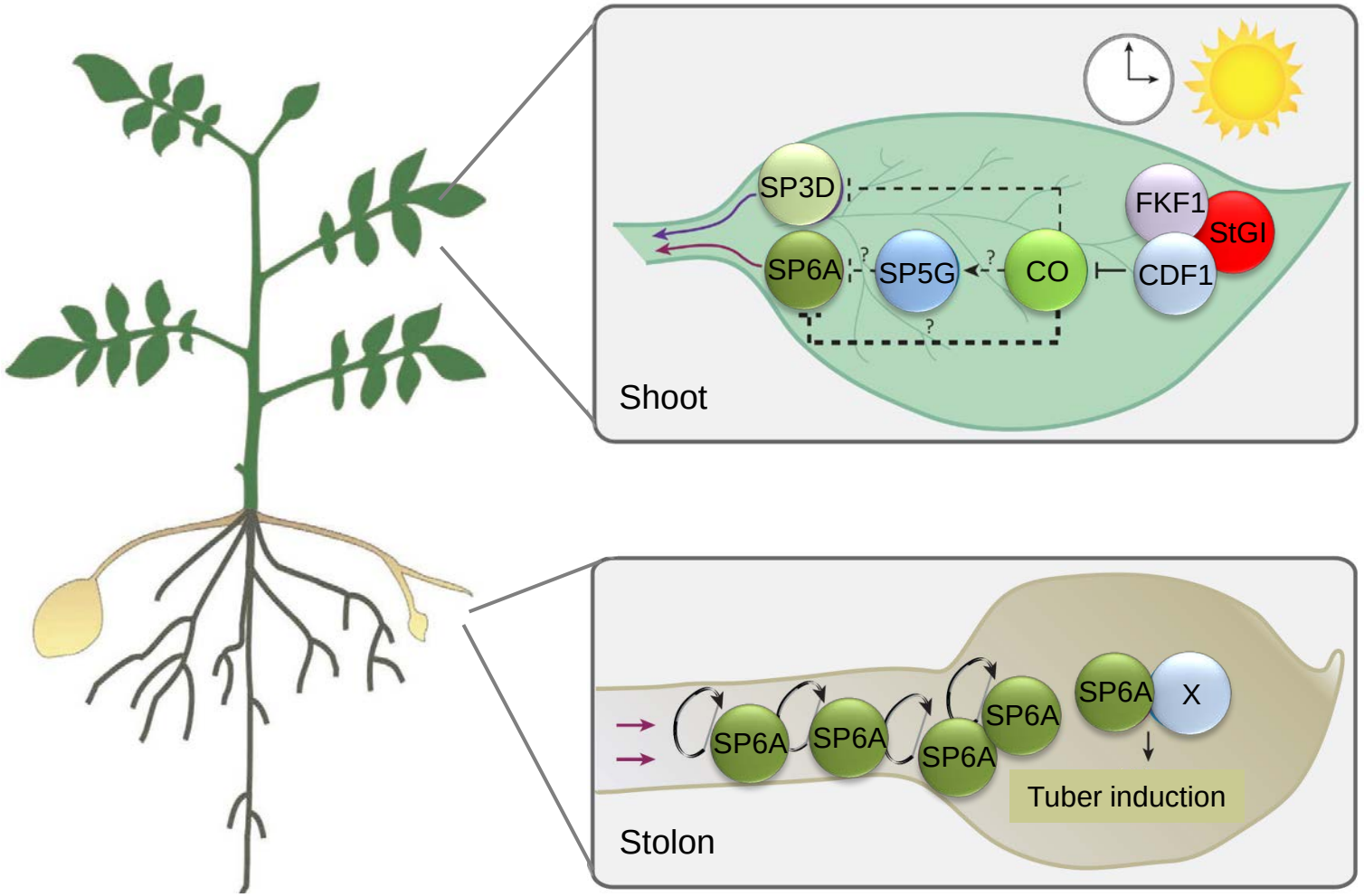
Durchwuchs mit Kettenbildung

Durchwuchs mit Sprossbildung

Zwiewuchs am Kronenende (= Puppigkeit)

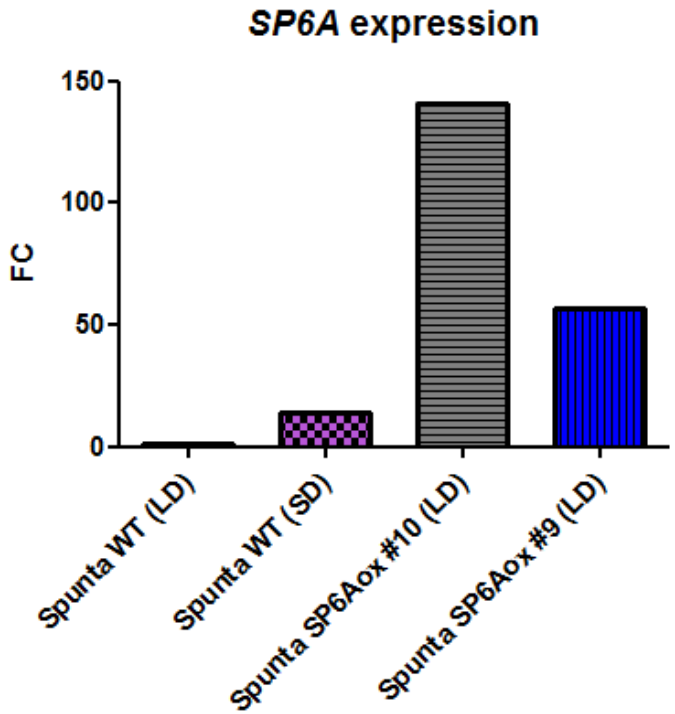
Fotos: BENKER 2010

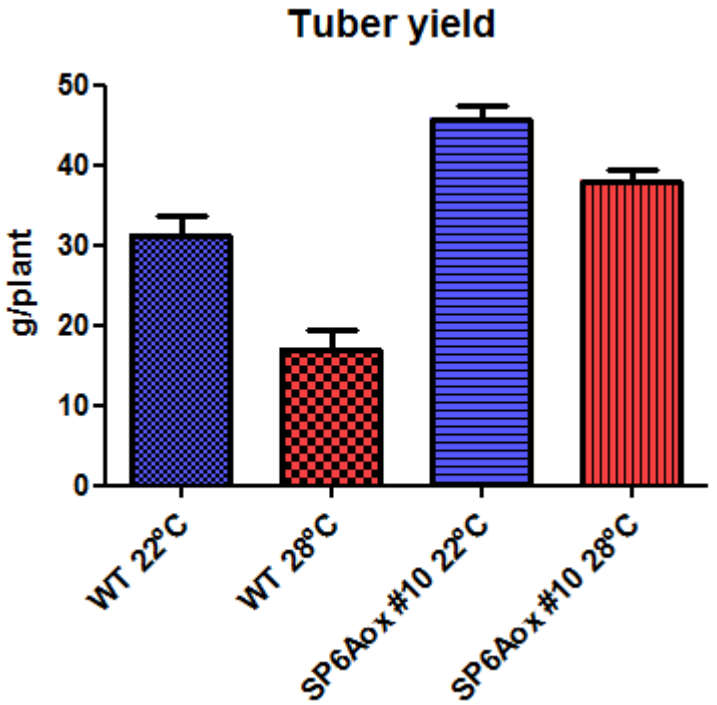
The model


SP3D
FKF1
StGI
SP6A
SP5G
CO
CDF1
Shoot
SP6A
SP6A
SP6A
SP6A
X
Tuber induction
Stolon

Testing SP6A over-expressing plants under high temperature

✓ SPUNTA SP6Aox – assay #1





***SP6A* overexpression** can **bypass** the **yield reducing effect** of **high temperature** conditions

120 days old plants

90 days of temperature treatment

SP6A overexpression prevents tuber secondary growth in elevated temperatures

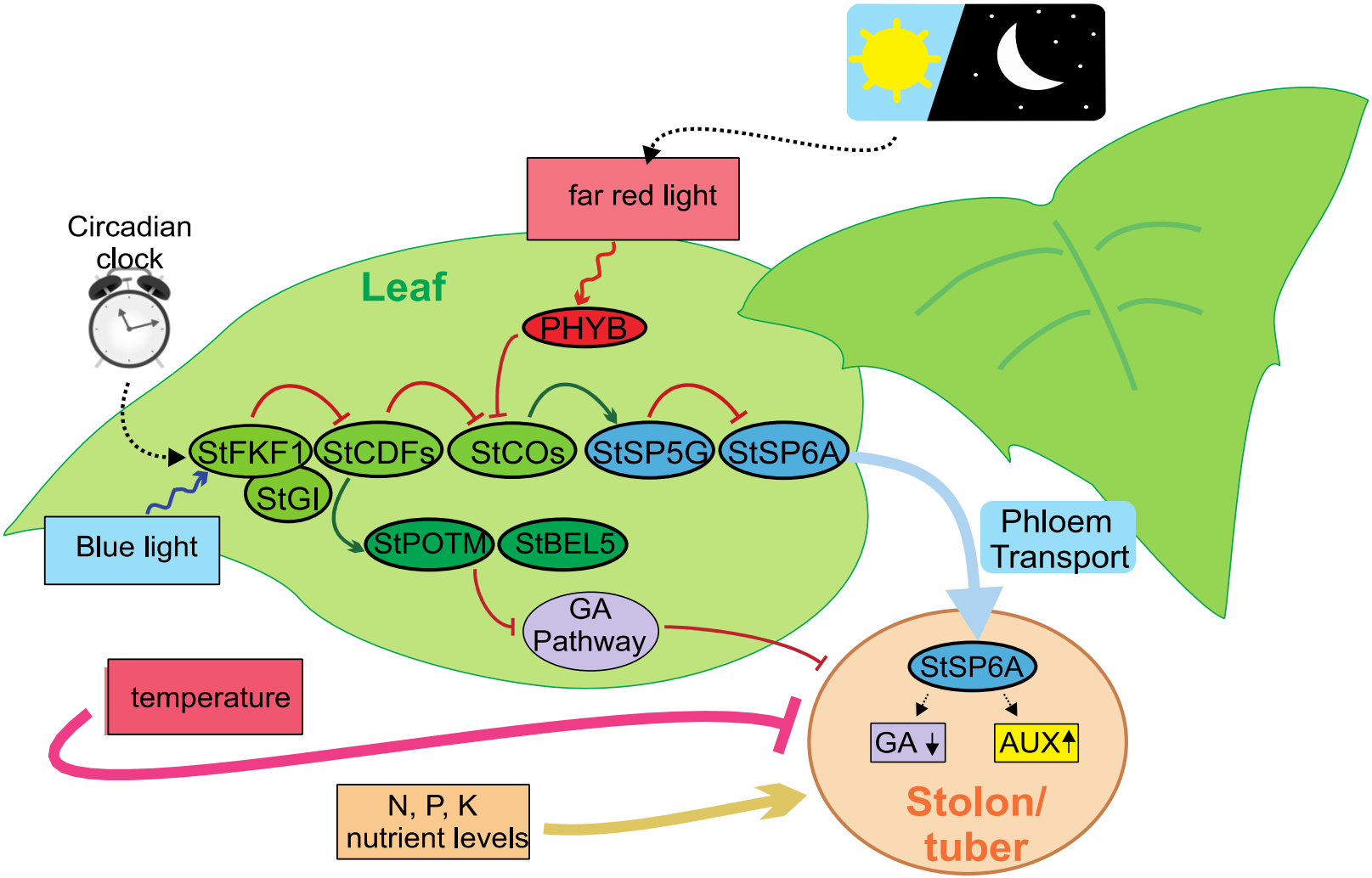
- SPUNTA SP6Aox – 2 different transgenic lines – assay #2

22ºC

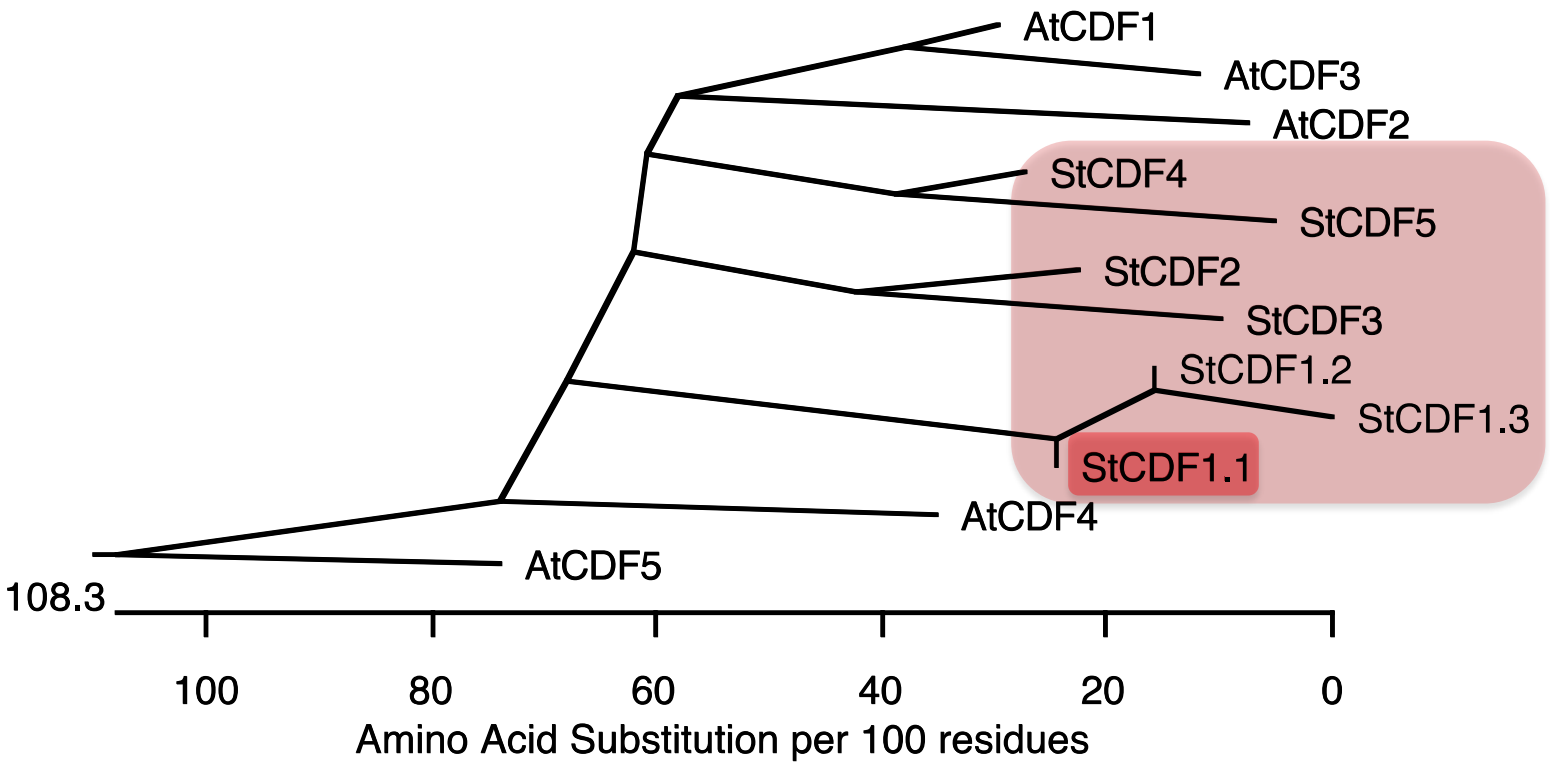
WT #10 #9

28ºC

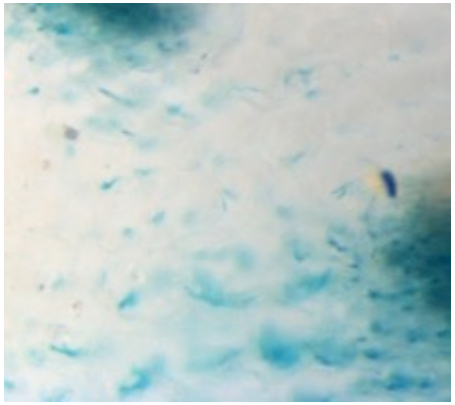
Eviromental inputs on gene expression

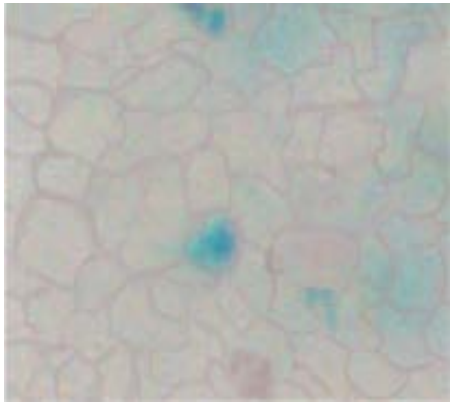


Potato has 5 StCDF genes related to AtCDF1-3



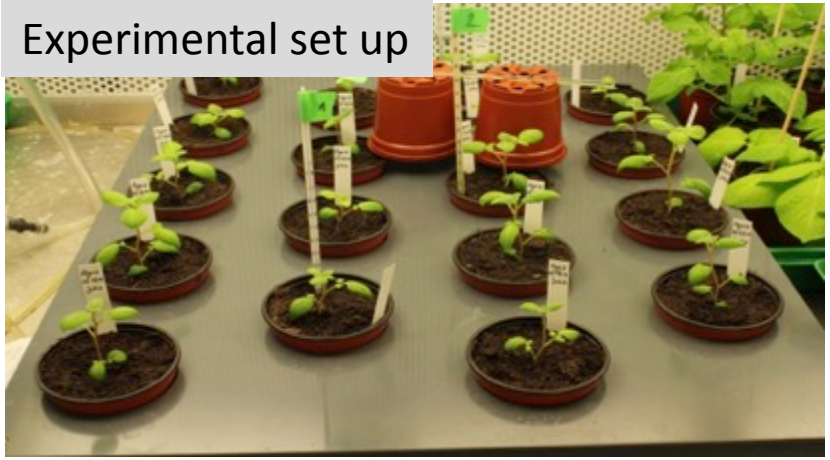
pStCDF1 Expression is restricted to the vasculature

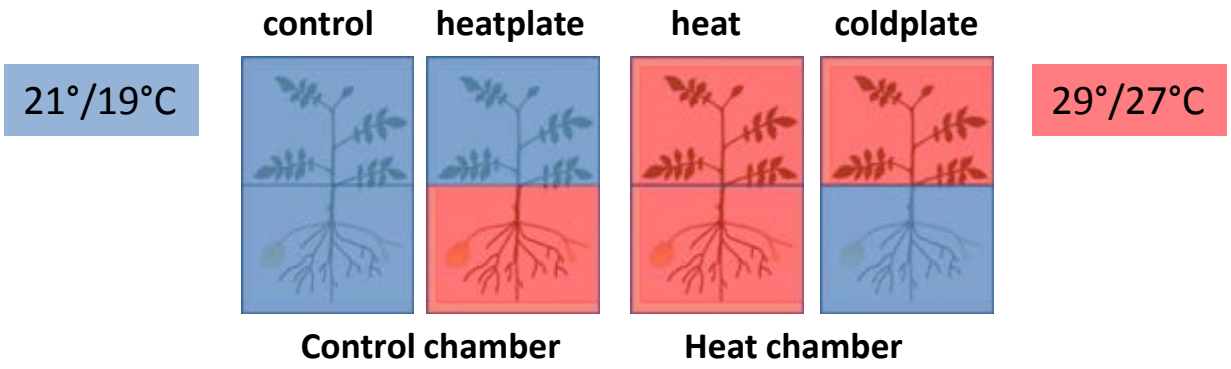




Deciphering responses of elevated leaf and / or tuber temperatures on assimilate partitioning, tuberisation, dormancy

Experimental set up

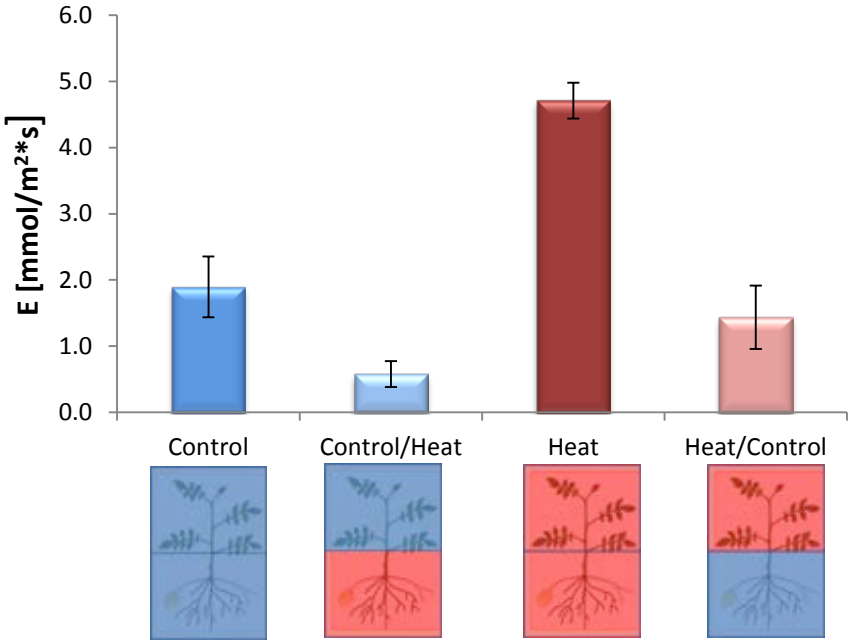




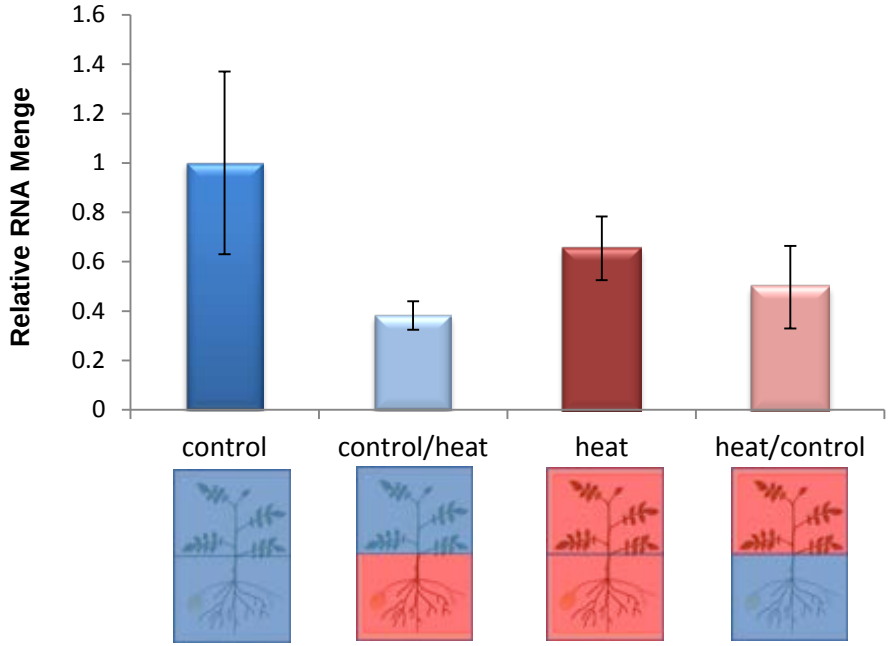
Sophia Sonnewald/ Uwe Sonnewald

Impact of altered air and / or soil temperatures on *SP6A* expression

Transpiration rate



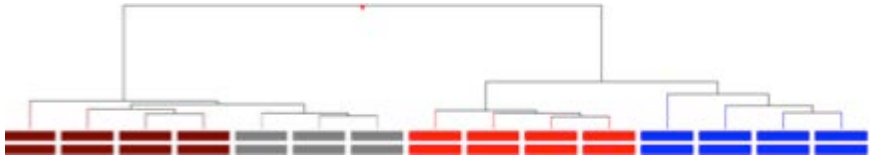
SP6A mRNA accumulation

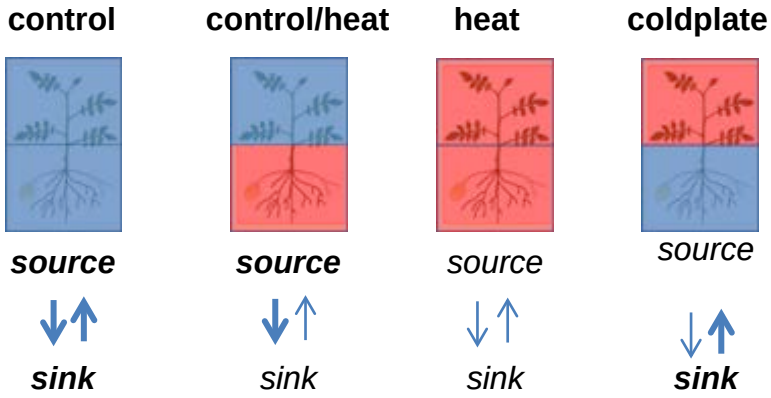


Sophia Sonnewald/ Uwe Sonnewald

Impact of altered air and / or soil temperatures on gene expression

Microarray analysis of leaf samples:

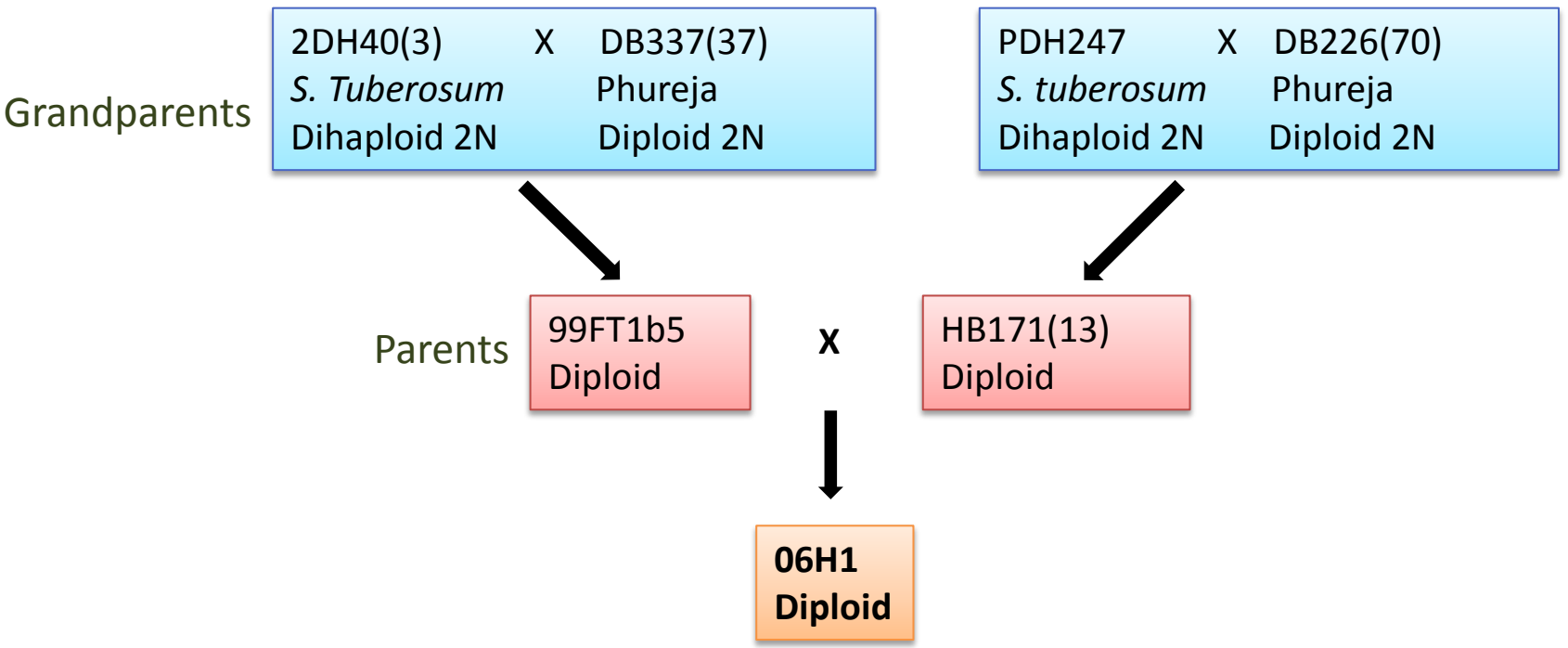




comparisons	total number of differentially expressed features	up-regulated	down-regulated
heat vs. control	3017	1654	1363
heatplate vs. control	517	403	114
coldplate vs. control	4319	1996	2323
coldplate vs. heat	1382	432	950

Sophia Sonnewald/ Uwe Sonnewald

Genetic mapping Heat tolerance in diploid population

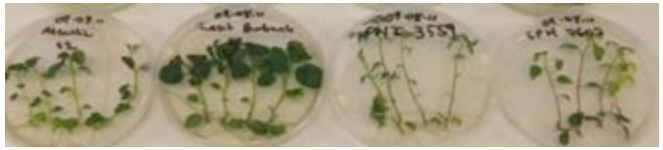


Population segregates for resistance to Late blight, PVY, PVS, powdery scab, Pectobacterium

Genetic map with ~2500 mapped markers

Prashar, Ankush, et al. "Construction of a dense SNP map of a highly heterozygous diploid potato population and QTL analysis of tuber shape and eye depth." Theoretical and Applied Genetics (2014): 1-13

Genetic approaches to identify alleles that confer tolerance to heat stress (WP4)



Plants synchronised in tissue culture

Plants grown in glasshouse

Stem cuttings prepared

Stem cuttings moved to controlled environment

Harvest

Enables high throughput screening under controlled conditions

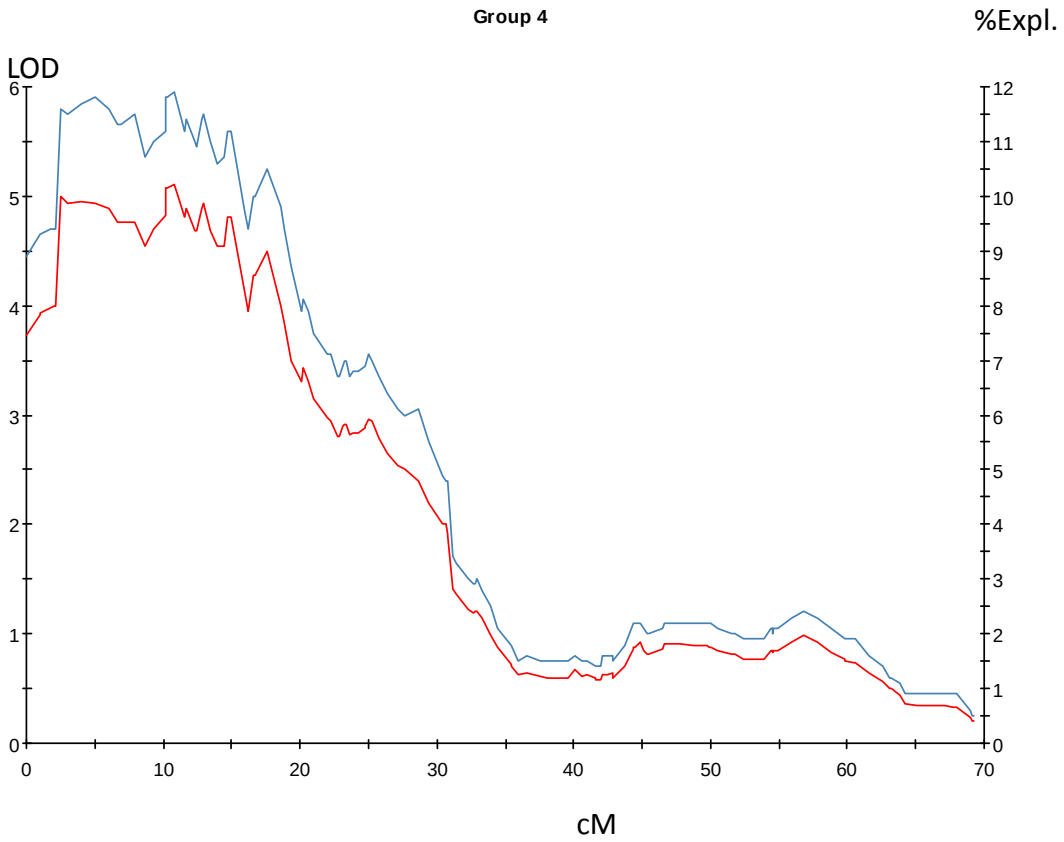
The James Hutton Institute

QTL analysis under heat

Association between quantitative traits and molecular markers (SNP) to find a candidate gene

06H1

Tuber fresh weight at 28^{0}C



Main conclusions and future prospects

- The photoperiodic pathway for tuberisation is intimately linked to abiotic stress signal transduction
- StSP6A is the ultimate output effected by elevated temperature – this opens the possibilities of engineering tolerance
- Source-sink relationships are fundamentally changed under high temperature – dissection of sensing and signal transduction is vital
- Mapping genetic variation allows the pin-pointing of novel pathways in regulation of tuberisation

Thank you for your attention!

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NWO, DFG, BBSRC & Breeding companies

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