What can we expect from transcription factors and phytohormones for the improvement of plant yield in arid conditions?

Stanley Lutts

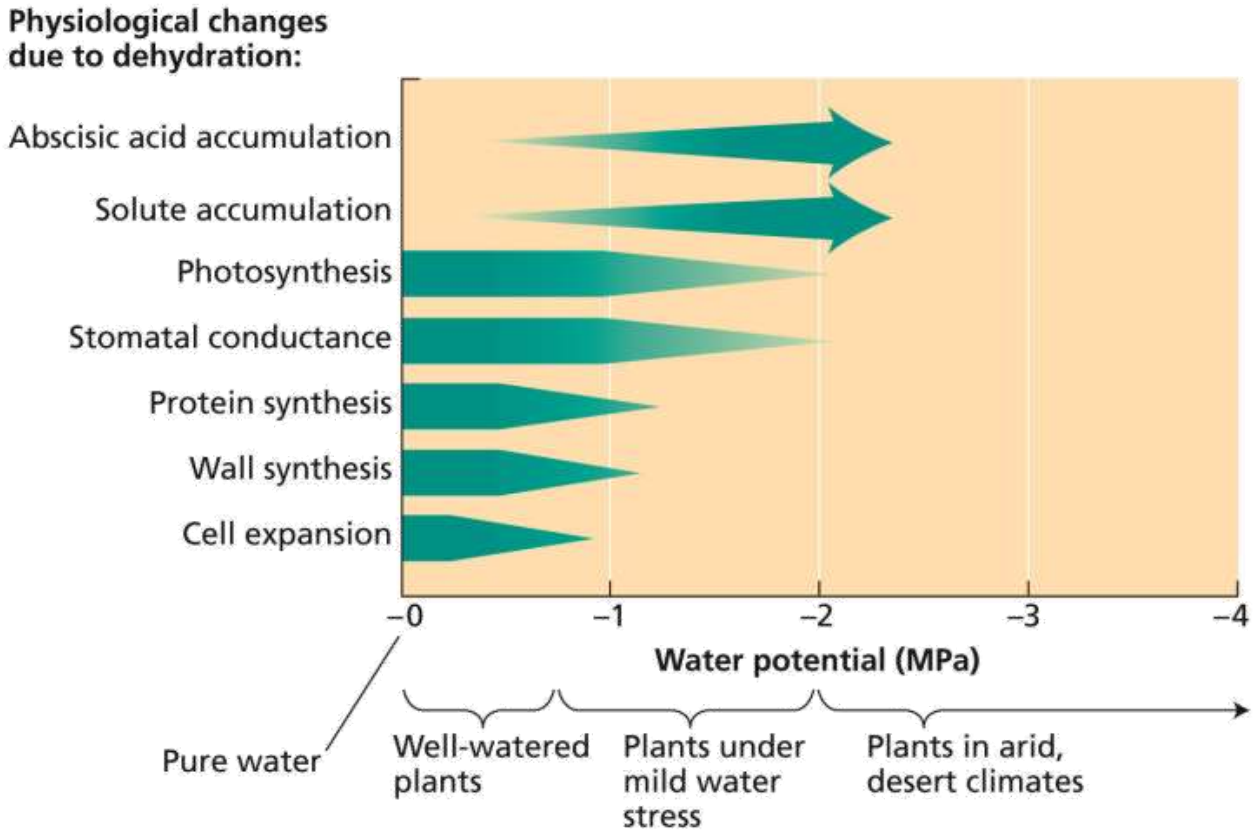
Catholic University of Louvain

Earth and Life Institute – Agronomy

Research Group in Plant Physiology

1. Introduction

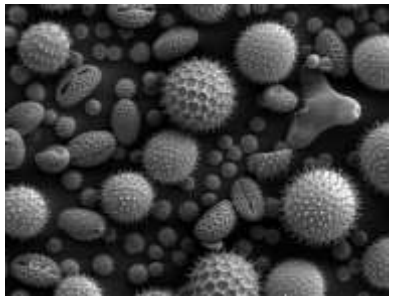
Selection of new plants needing less water

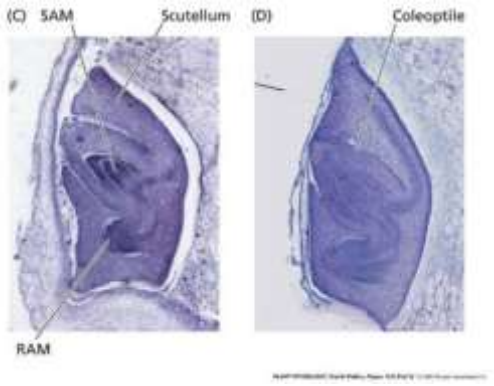


but……not only a problem of water stress

- High temperatures
- High irradiance
- Nutrient deficiencies

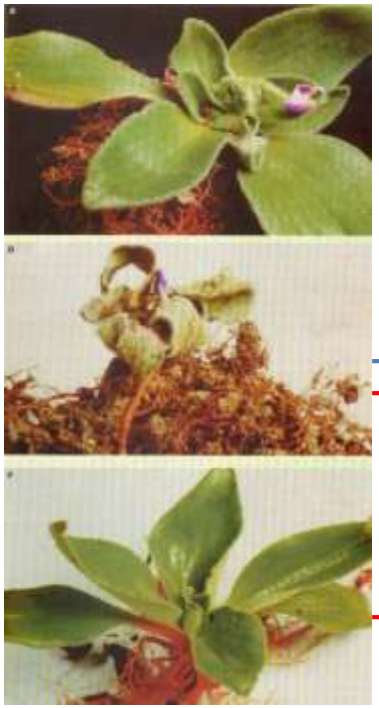
Most plants have genes of desiccation tolerance





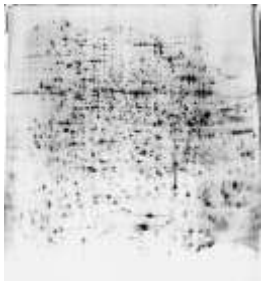
Where? When ? Why?

……some of them express those genes in a surprising way…….



Craterostigma plantagineum

Poikilohydric Resurection plant



Proteins Genes

LEA
Dehydrins
BSP

The problem is more related to the expression and regulation of genes than to possession of of specific genes

……. And what occur after stress relief……???

3. Efficient screening methods for plant breeders

…should be rapid, cheap and allow precocious identification of promising genotyes

$$\delta^{13}C_{\text{Sample}} = \left(\frac{{}^{13}C/{}^{12}C_{\text{Sample}}}{{}^{13}C/{}^{12}C_{\text{PDB}}} - 1 \right) \cdot 1000$$

Carbon isotope discrimination

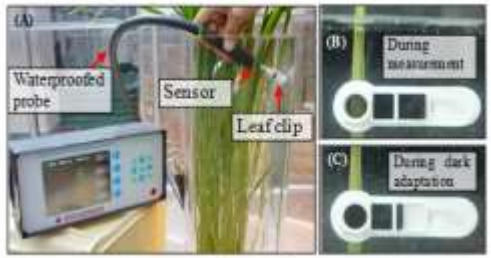
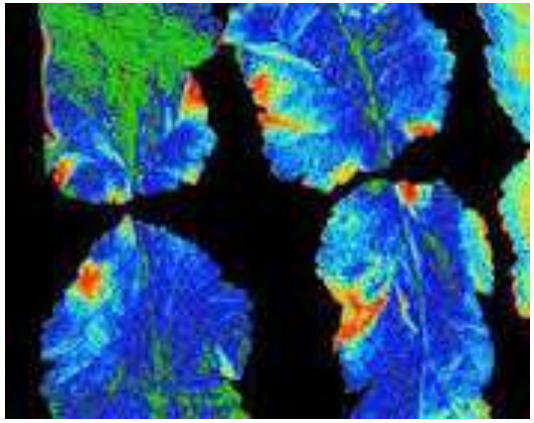
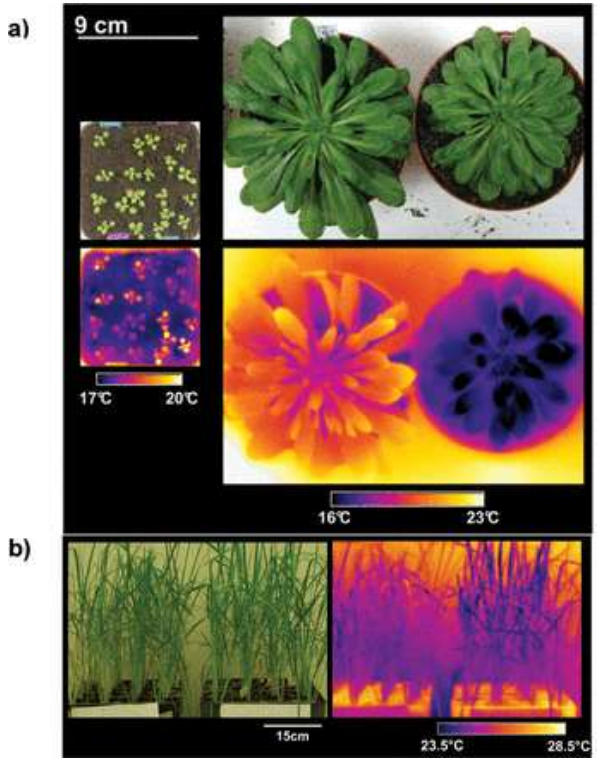


Fig.1. The measurement system of chlorophyll fluorescence in rice leaves underwater.

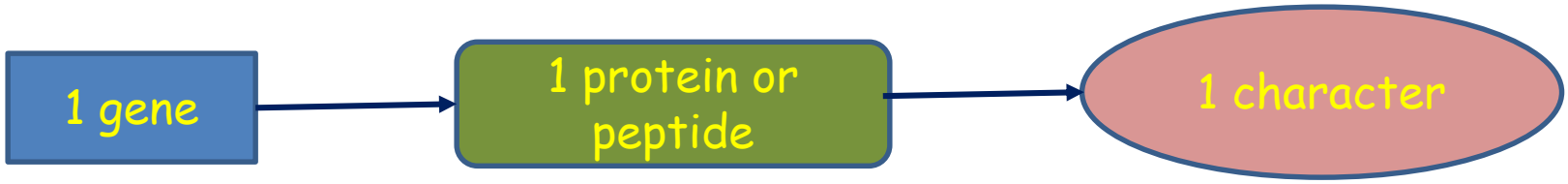


Chlorophyll fluorescence

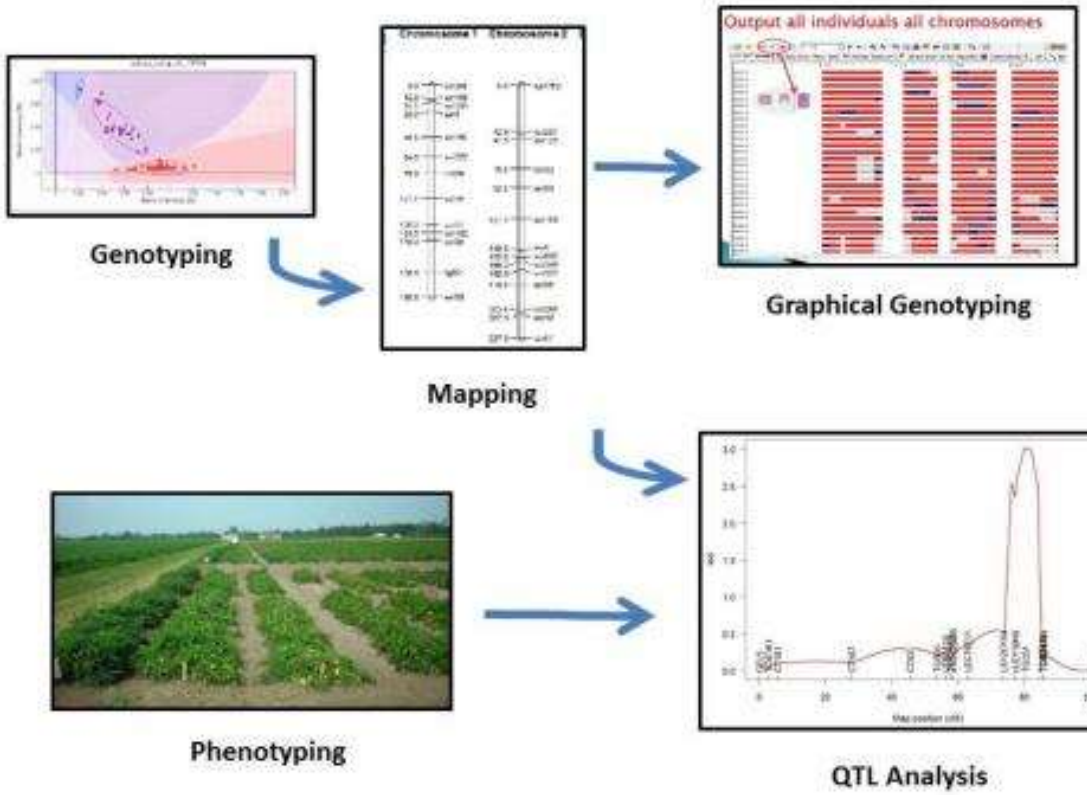


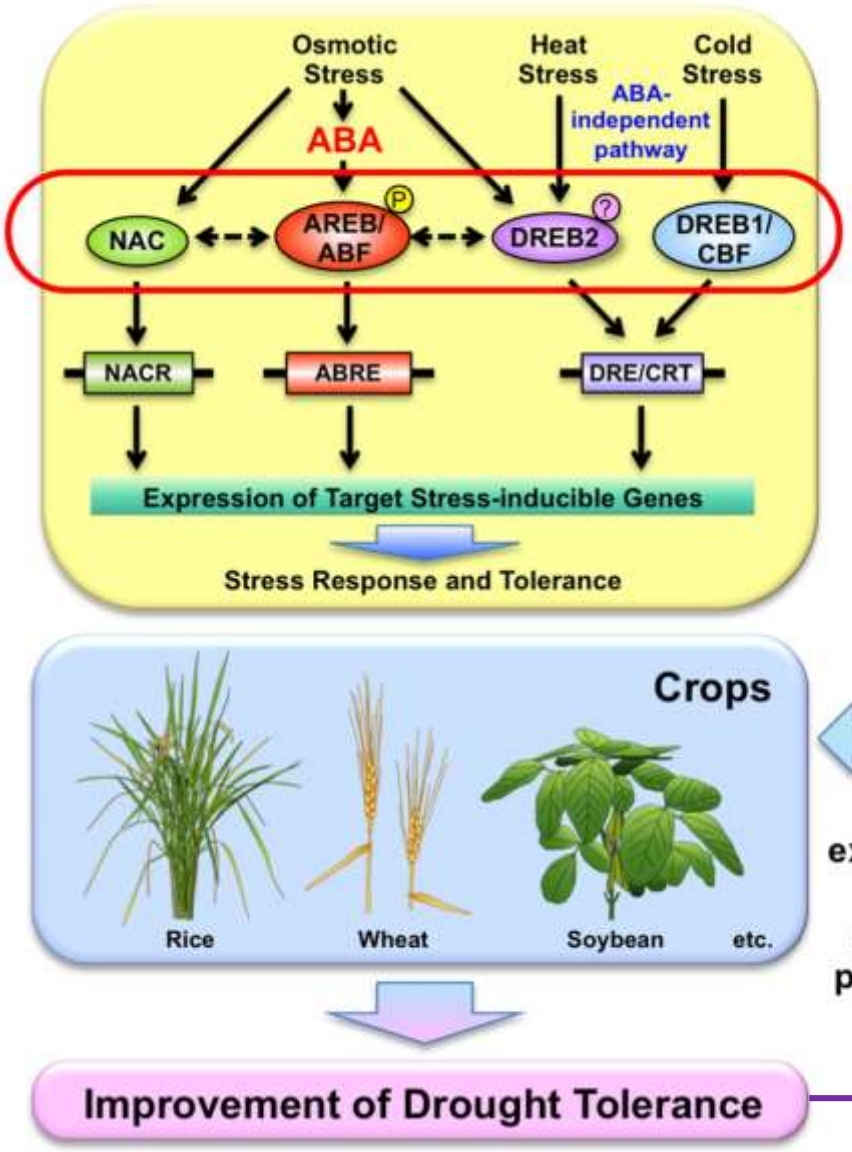
Thermography

4. Efficient breeding methods ?



But stress resistance is a quantitative property: 1 character – several genes





Key TFs

Over-expression using suitable promoters

Tanscription factors

Interesting alternative

One protein encoded by one gene control the expression of several genes

One target acting on several parameters

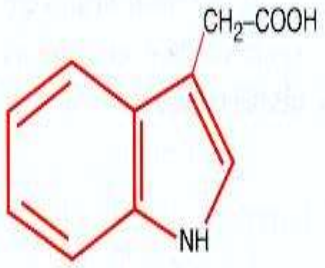
- One given TF may transduce different constraints

!!! One single TF may contribute to resistance against various stresses !!!

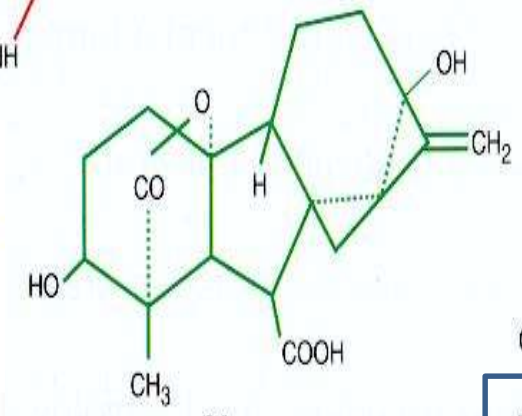
+++ heath? UV?, salt…..??

Plant growth regulators: phytohormones

Increase water stress resistance ??



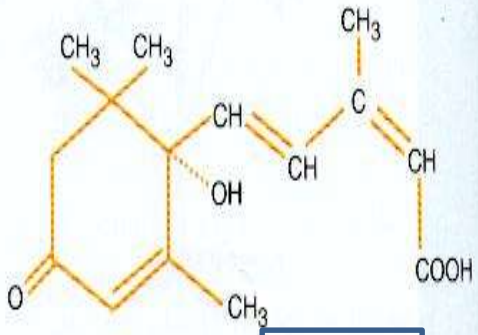
AIA



GA4

ZÉATINE

Antisenescence



ABA

CH2=CH2

ÉTHYLÈNE

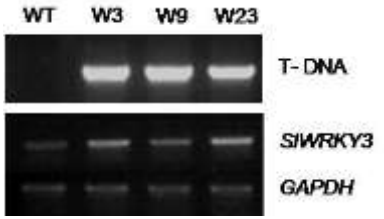
« stress hormones »

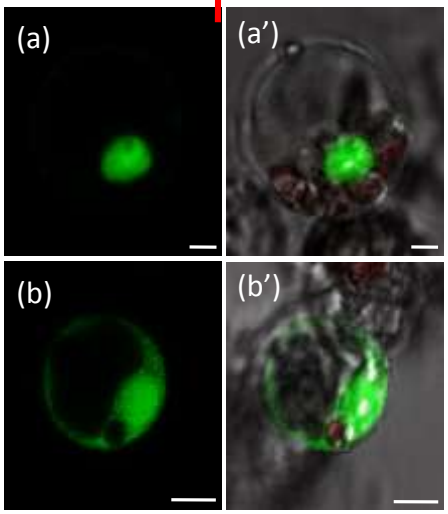
senescence → Organ or plant death

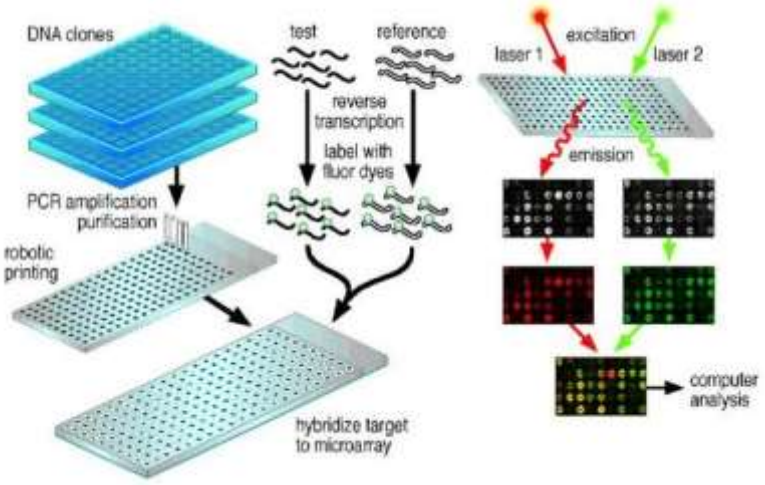
Tansgenic plants used ONLY as experimental material in the lab.

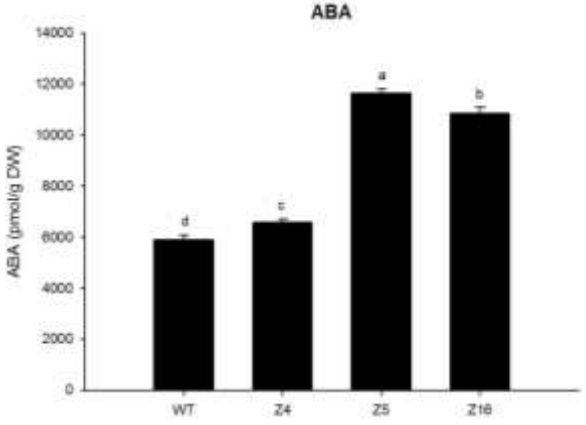
WRKY

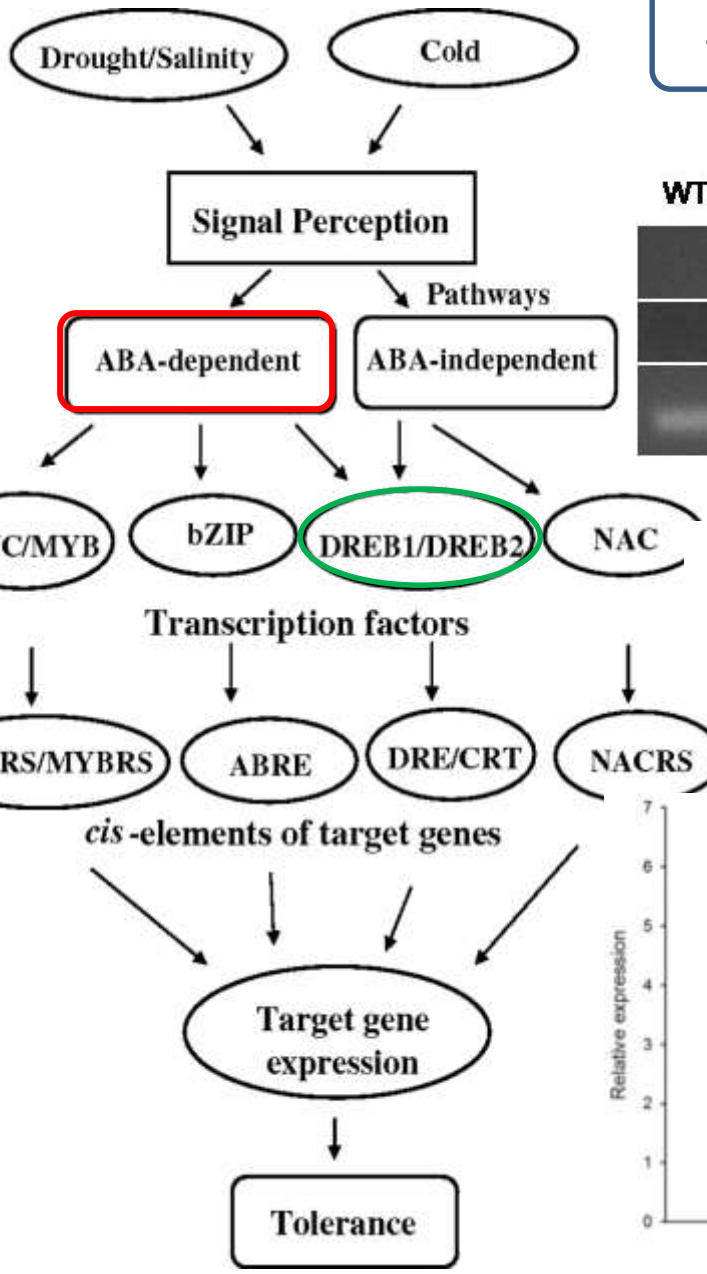
SlZF2 Cys2/His2 repressor-like zinc-finger



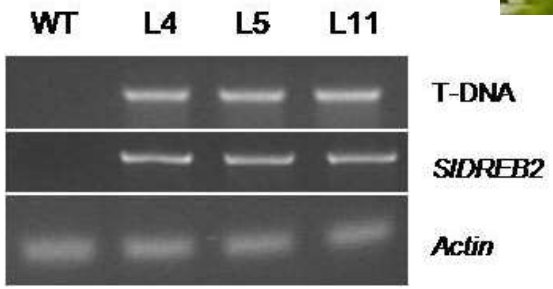






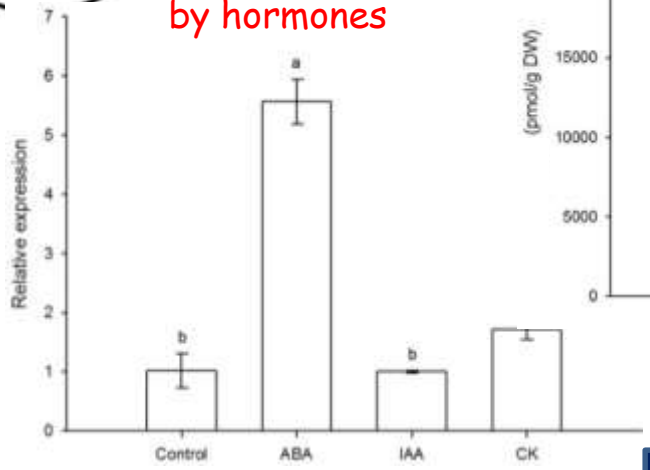


SlDREB/AP2

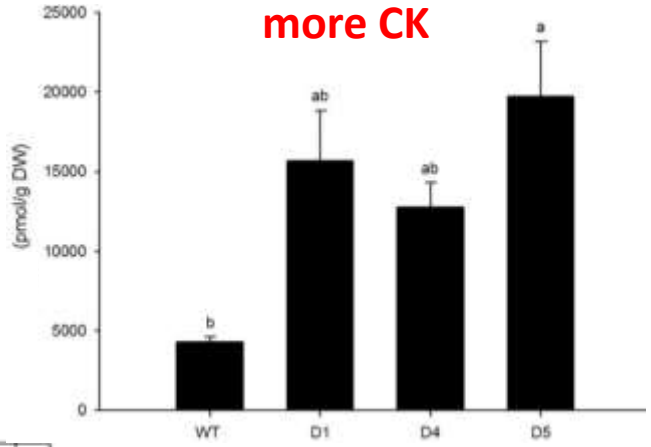


Putative cis-element

TF are induced by hormones



more CK



TF modify hormonal status

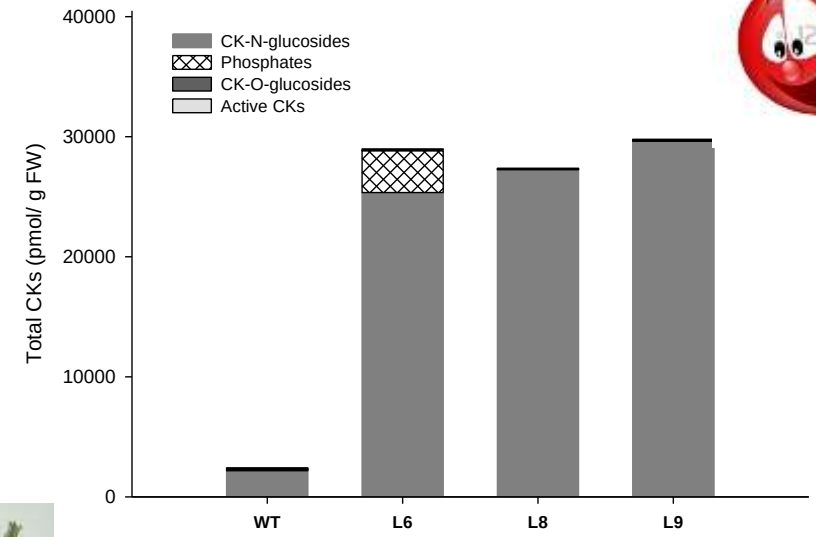
TF and PGR interact

Plants over-exppressing IPT (involved in cytokinin synthesis)

Better growth
Higher survival rates
Improve of WUE
Higher photosynthesis

….during vegetative phase

but



Deleterious impact of constitutive exression on flowering

Cytokinins are not needed all the time everywhere: choose the correct promoter

Why? Where? When? → Roots ; early phase of stress

Solanum chilense, S. peruvianum, S. cheesmannii, S. pennelli

Grafting

Wild tomatoes:
very resistant
to abiotic stress

Identification on the basis of:

- Sites of cytokinins production and accumulation
- Expression of transcription factors

Best combination needing less water

Interspecific hybrid: *Solanum lycopersicum* x wild species

Inia – La Cruz

Commercial tomato cultivar

Thank you