Revealing a polyamine-ethylene regulatory node linked to drought resistance/susceptibility in oat.

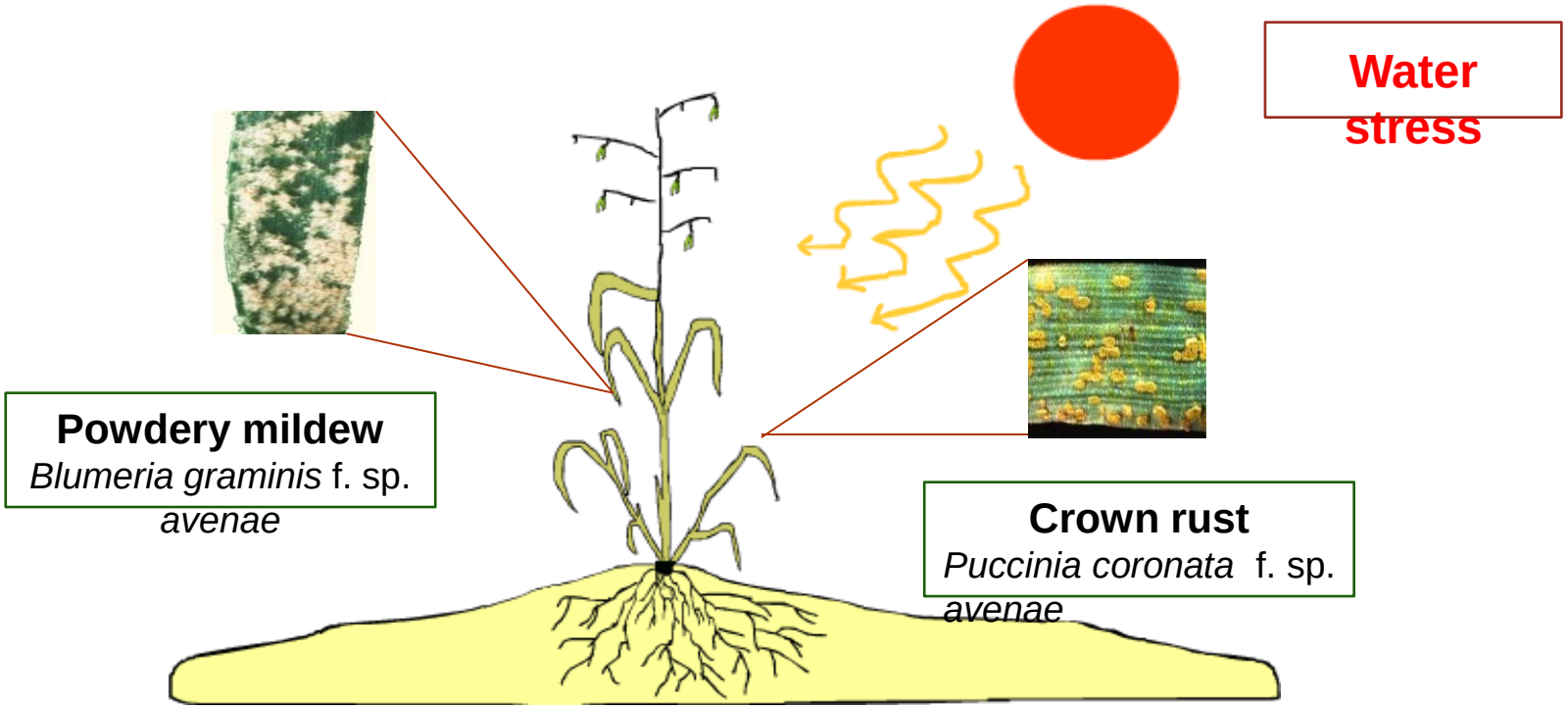
Gracia Montilla-Bascón, Francisco José Canales, Luis AJ Mur, Elena Prats

Institute of Sustainable Agriculture

Spanish National Research Council (CSIC)

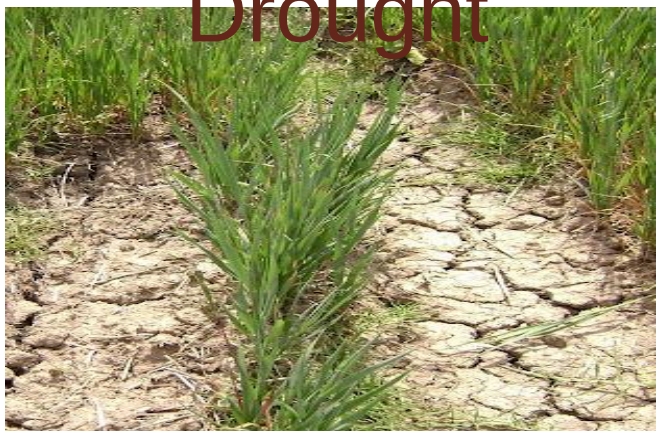
Biotic and abiotic stresses:

The external conditions adversely affect growth, development and productivity of the plants



Breeding programmes improve the yield, quality and economic productivity of this crop.

Abiotic stresses: Drought



Water is the most important and limiting factor

Effects drought on plants

- Effects on crop growth and yield
- Assimilation partitioning
- Nutrients: availability, uptake, translocation, and metabolism.
- Water relations: RWC, leaf water potential, stomatal resistance, etc.
- Photosynthesis.

Mechanism of adaptation to drought stress

➢Escape

Shortening of the crop duration to complete life cycle before stress.

➢Avoidance mechanisms

Increasing its ability to avoid damage by keeping the water content high in the plants tissues.

➢Tolerance Mechanisms

Maintenance of metabolic functions under water limiting

Oat is specially sensitive to drought stress

Oats have an important root system that explores the soil well,

however…

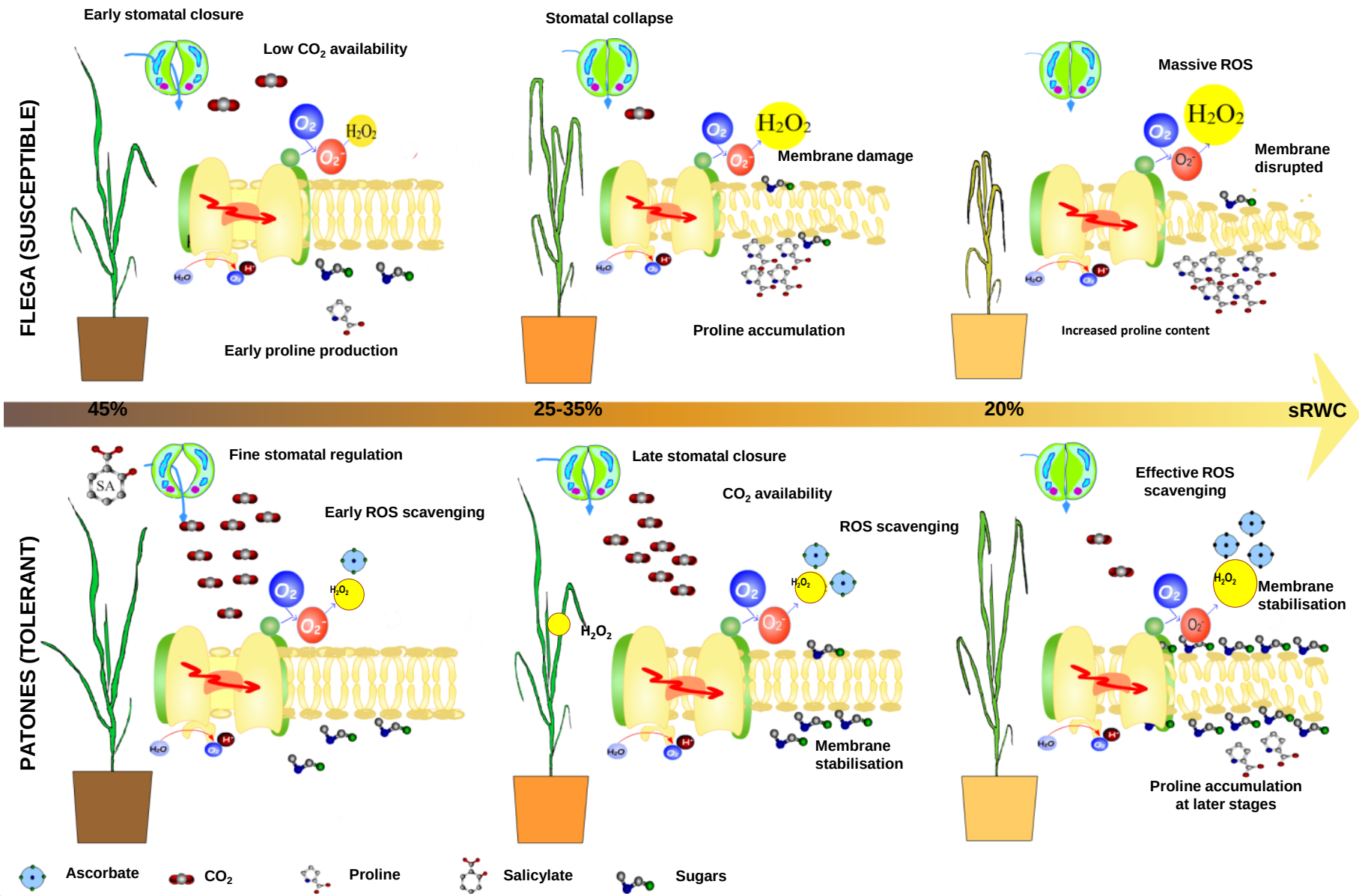
- ✓ Transpiration rates higher than in other small grain cereals (i.e. Ehlers, 1989; Coffman and Frey, 1961; Peltonen-Sainio, 1999).
- ✓ Higher water requirements than other small grain cereals
- ✓ Especially susceptible to grain abortion caused by drought and heat

Drought Resistance

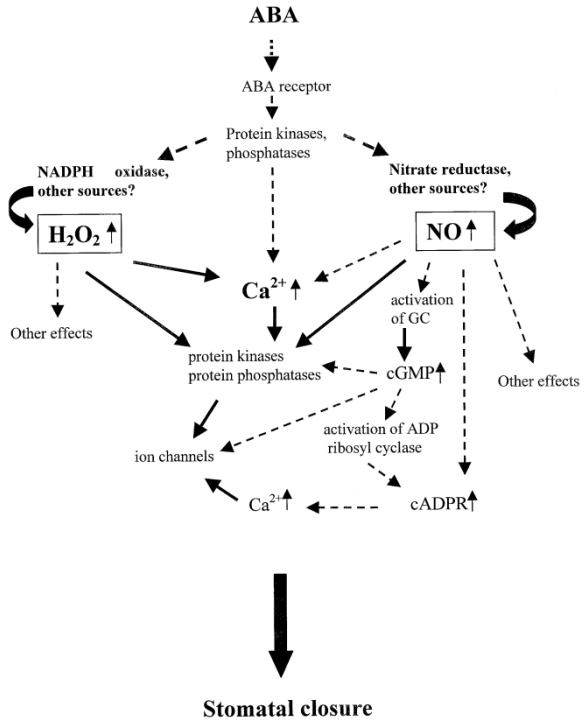
↓

Important target….
But low heritability and high GxE

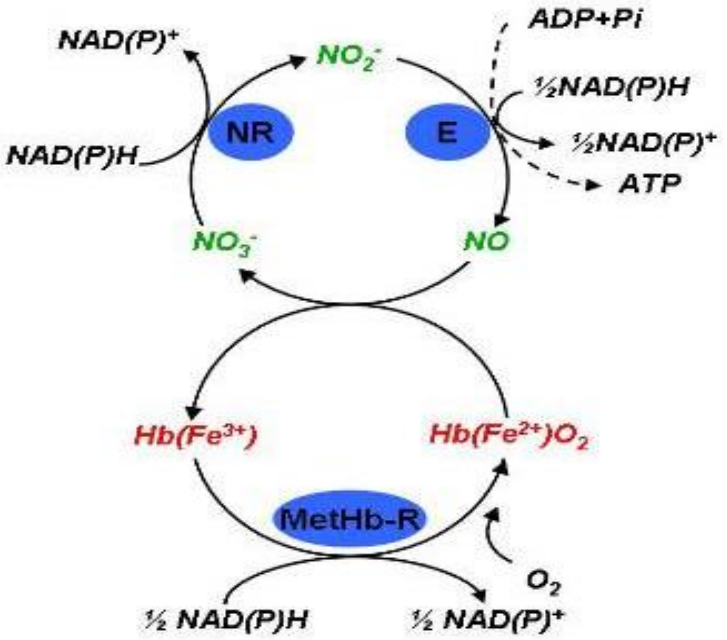
Drought resistance mechanisms in oat



Nitric oxide (NO)



(Obtained from Desikan, R. et al., 2003)



Haemoglobin, scavenging of NO (Hb/NO cycle)

Barley non-symbiotic gen HvHb1 oxides NO to NO_3^-

↓ **NO levels** ↑ **Drought resistance**

WT
(Golden Promise)

UHb
Overexpressing HvHb1 gen

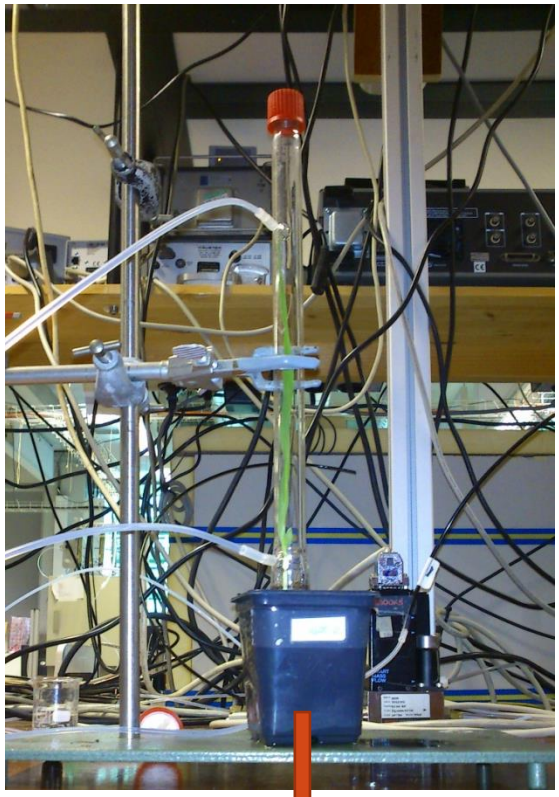
Quantification of NO *in vivo* in barley

WT
(Golden Promise)

HHb
Overexpressing HvHb1 gen

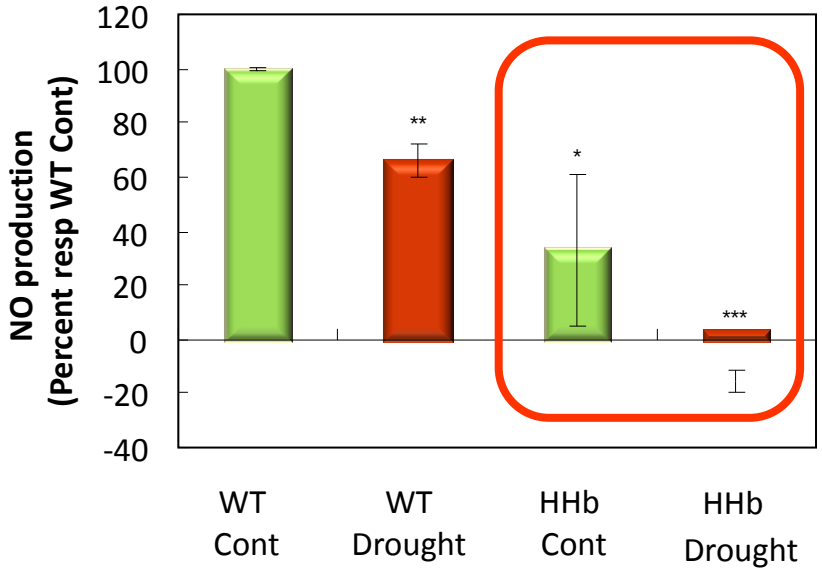
Institute of Molecules and Materials
Radboud University

Monitorized NO during drought cycle (18 days)



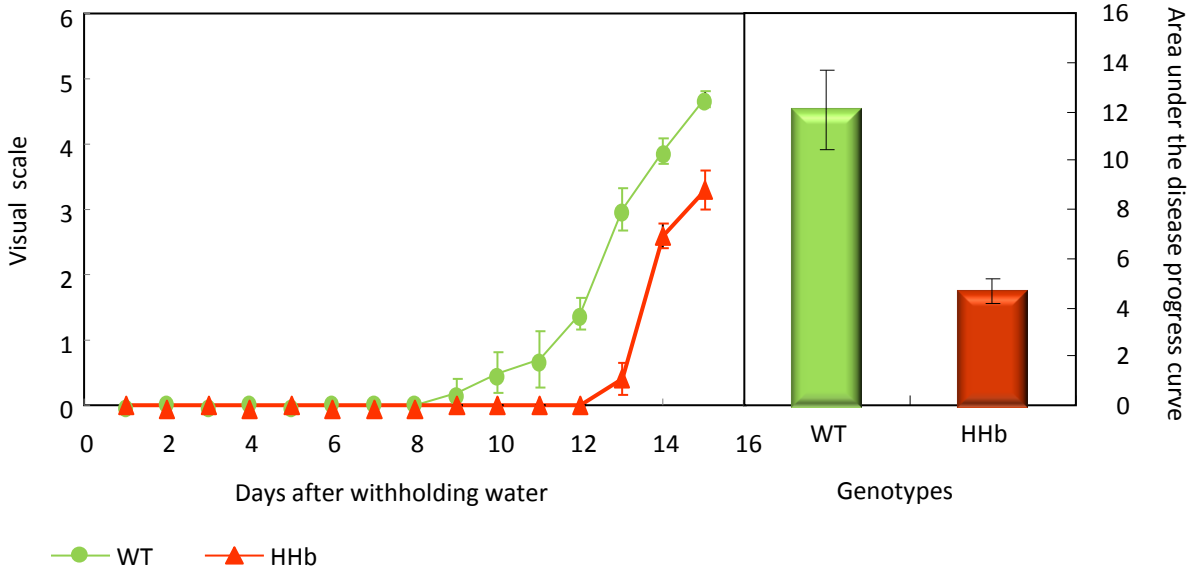
Spectrophotometer based on QCL (quantum cascade laser)

Quantification of NO *in vivo* in barley



HHb plants produce less NO than WT.

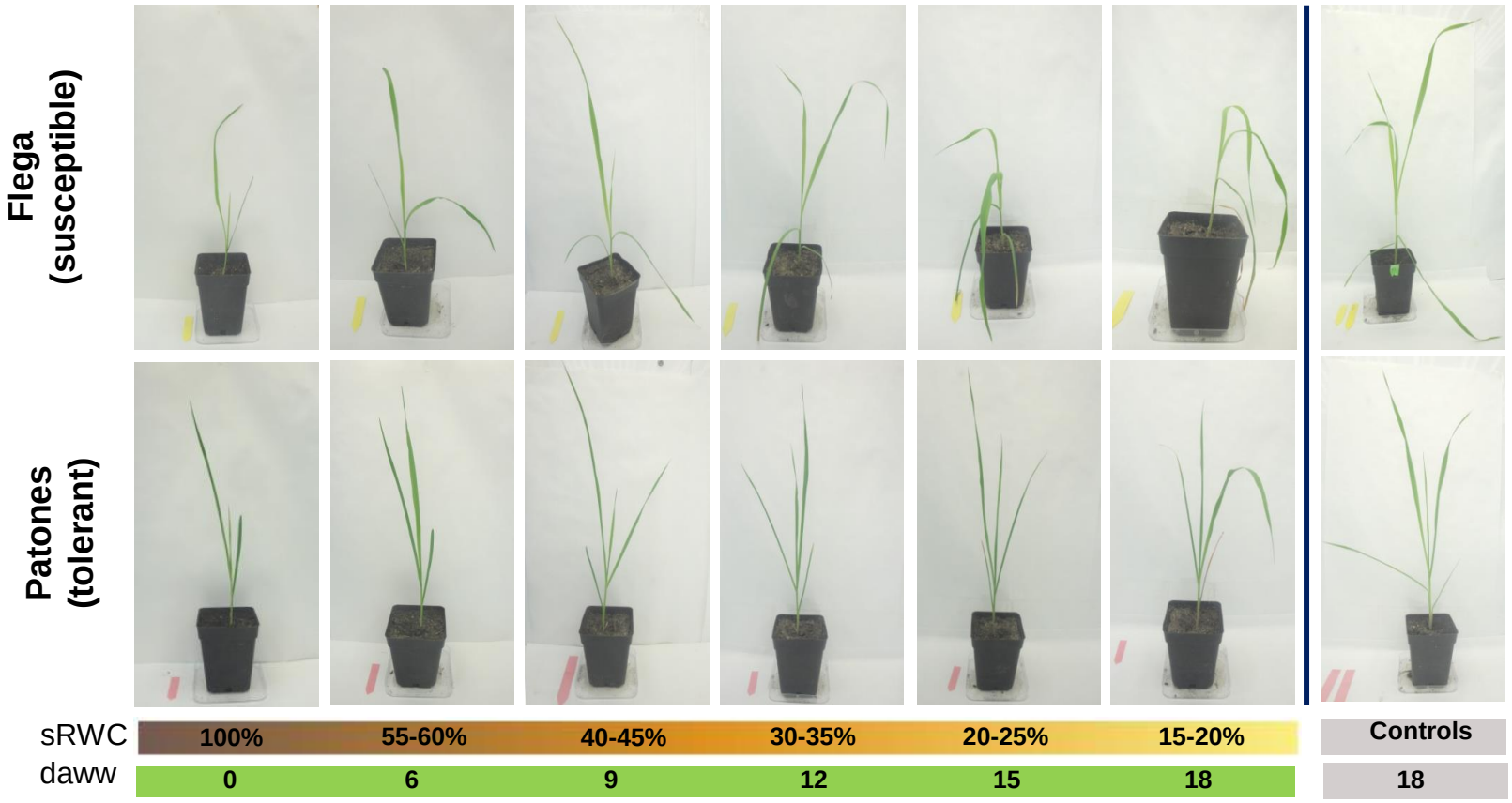
Differences more pronunciated under drought conditions



WT is more susceptible to drought than plants overexpresing HvHb1 gen and therefore, containing less NO

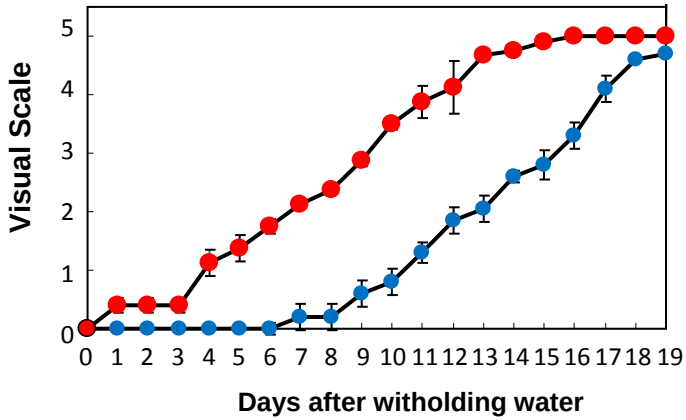
First question??

Inherent NO reduction in drought-resistant oats???



Quantification of NO *in vivo* in oat

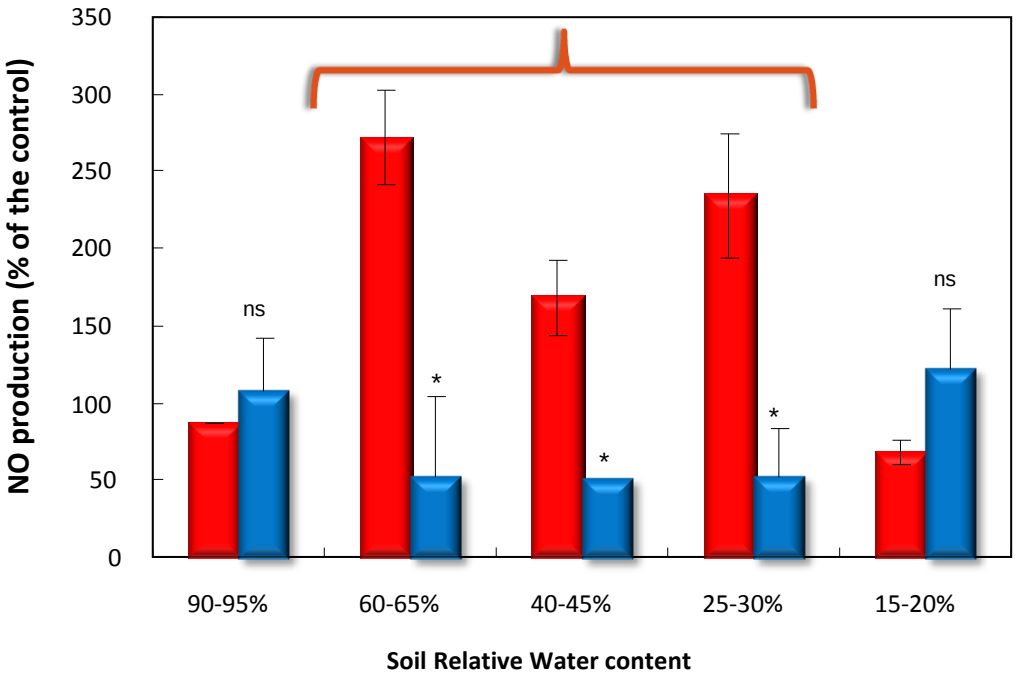
AUDPC



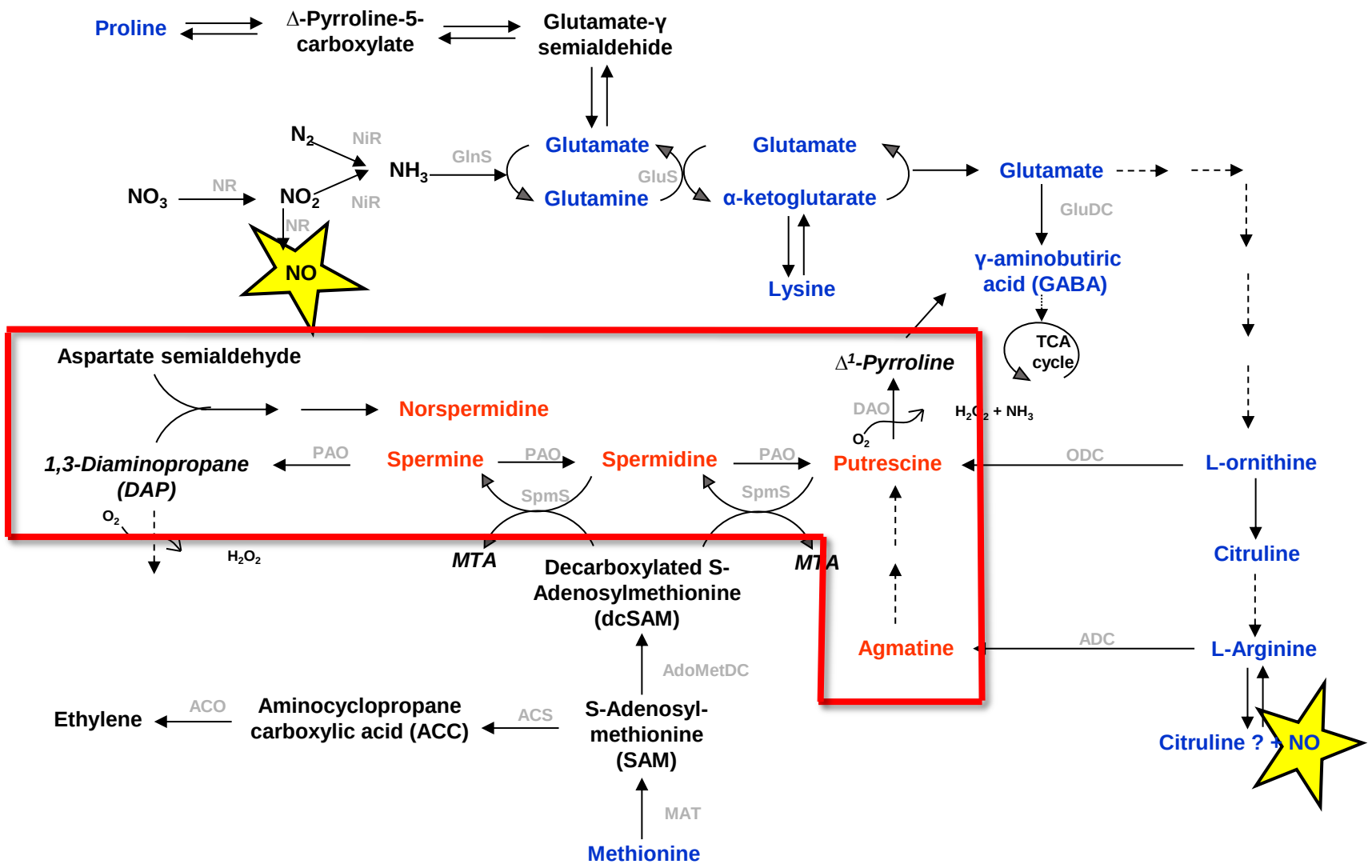
Flega
(susceptible)

Patones
(tolerant)

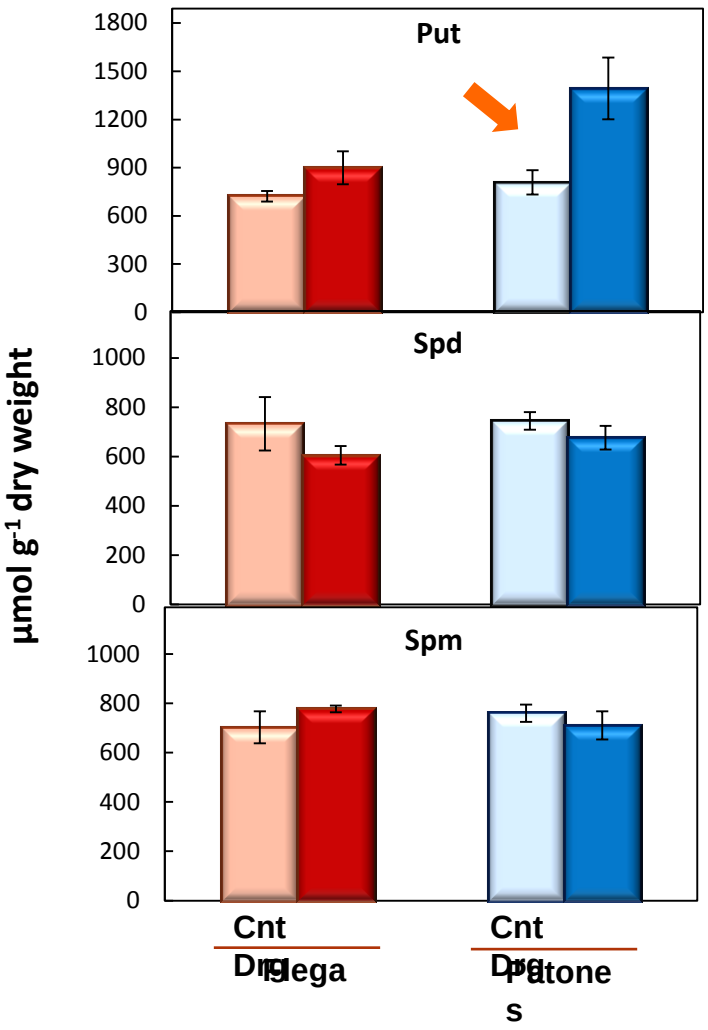
Resistant genotype produce significantly less NO during drought cycle.

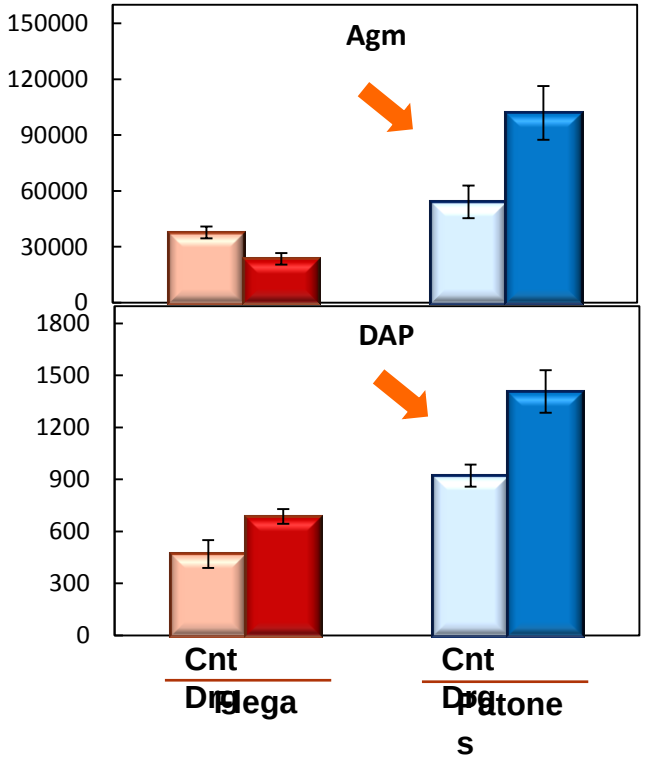


May NO influence drought resistance through polyamine pathway ????



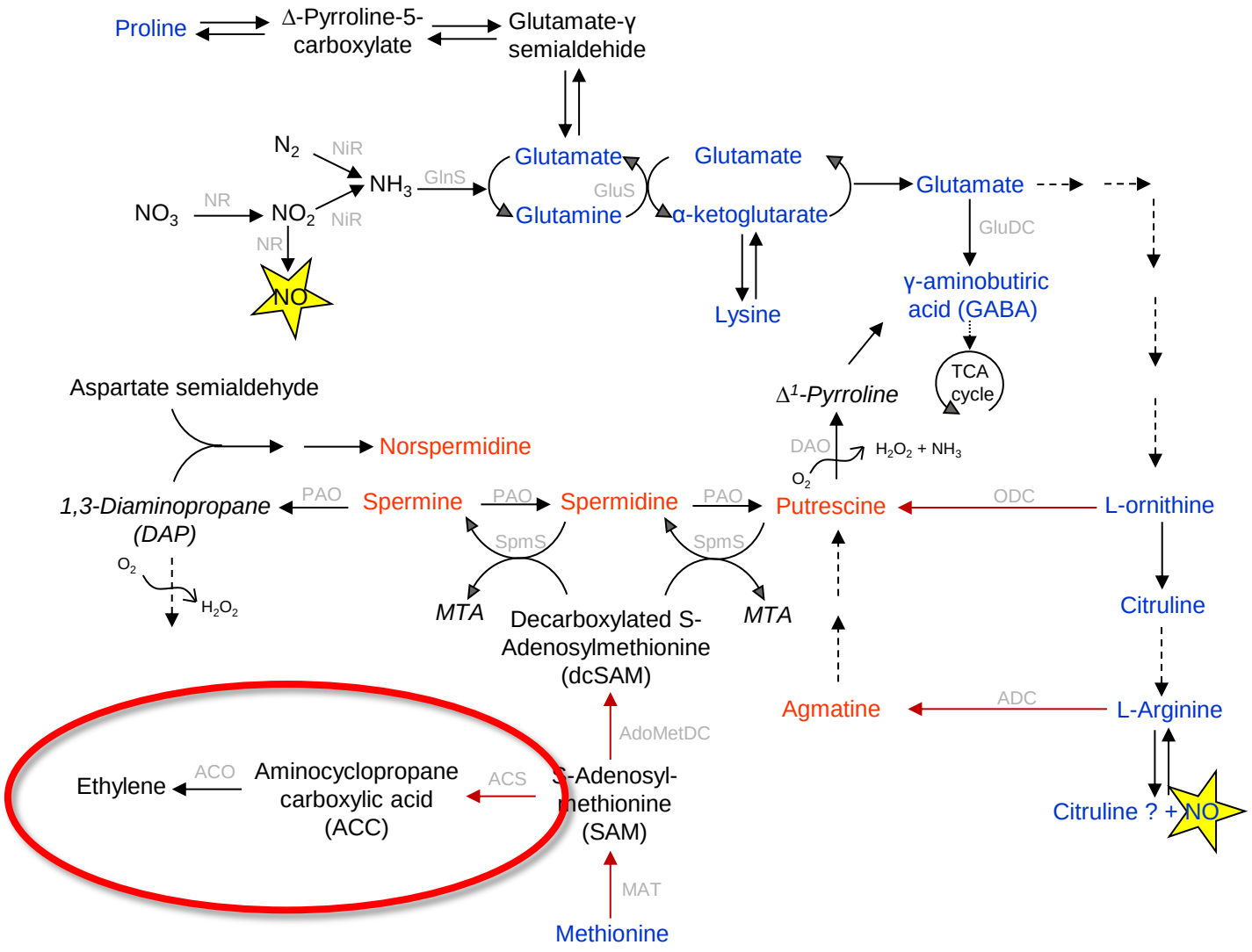
Polyamines quantification by HPLC





Significant differences in PAs content between both genotypes.

Ethylene ????

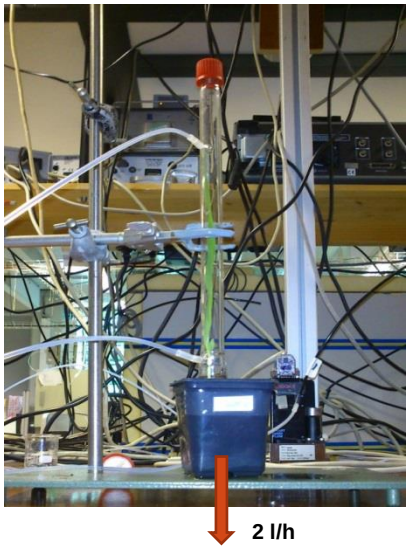

Proline
Δ-Pyrroline-5-carboxylate
Glutamate-γ semialdehide
N2
NiR
NH3
GlnS
Glutamate
Glutamine
GluS
Glutamate
α-ketoglutarate
Glutamate
GluDC
γ-aminobutiric acid (GABA)
TCA cycle
NO3
NR
NO2
NiR
NR
NO
Lysine
Δ1-Pyrroline
DAO
O2
H2O2 + NH3
Aspartate semialdehyde
Norspermidine
1,3-Diaminopropane (DAP)
PAO
Spermine
PAO
Spermidine
PAO
Putrescine
ODC
L-ornithine
O2
H2O2
SpmS
SpmS
MTA
MTA
Decarboxylated S-Adenosylmethionine (dcSAM)
Citruline
Agmatine
ADC
L-Arginine
AdoMetDC
Ethylene
ACO
Aminocyclopropane carboxylic acid (ACC)
ACS
S-Adenosyl-methionine (SAM)
Citruline ? + NO
MAT
Methionine

Quantification of Ethylene *in vivo* in oat

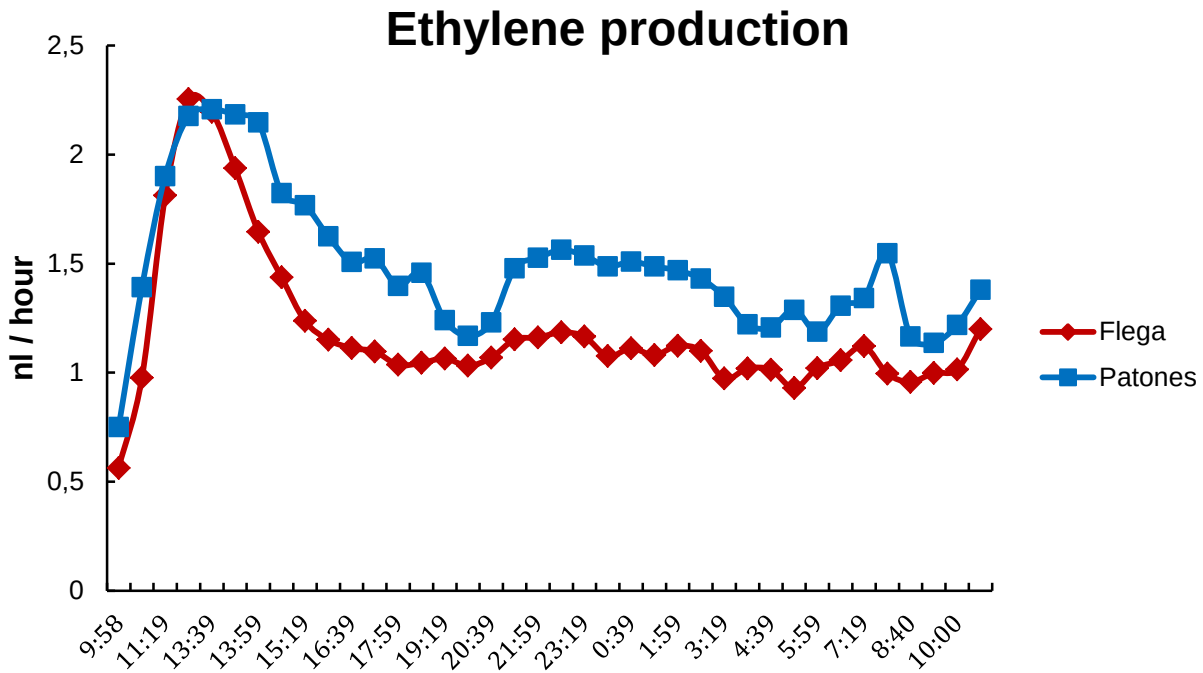
Spectrophotometer based on QCL (quantum cascade laser)

Air with Ethylene from plant — **1 l/h**

Air without Ethylene — **3 l/h**



2 l/h

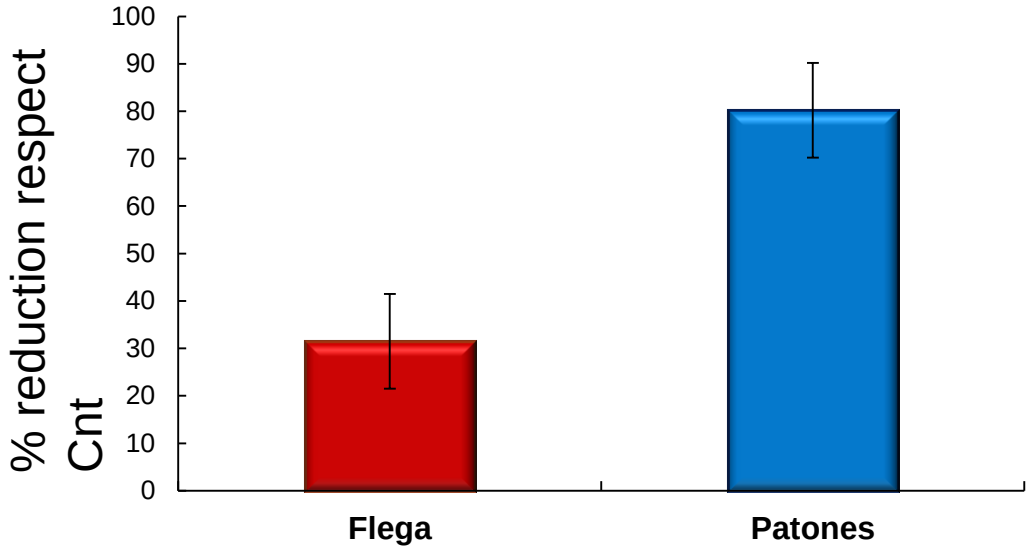


<u>Control conditions;</u>

Resistant genotype emitted more Ethylene

Quantification of Ethylene *in vivo* in oat

Reduction of Ethylene emission respect Control (well-watered plants) at 35% RWC

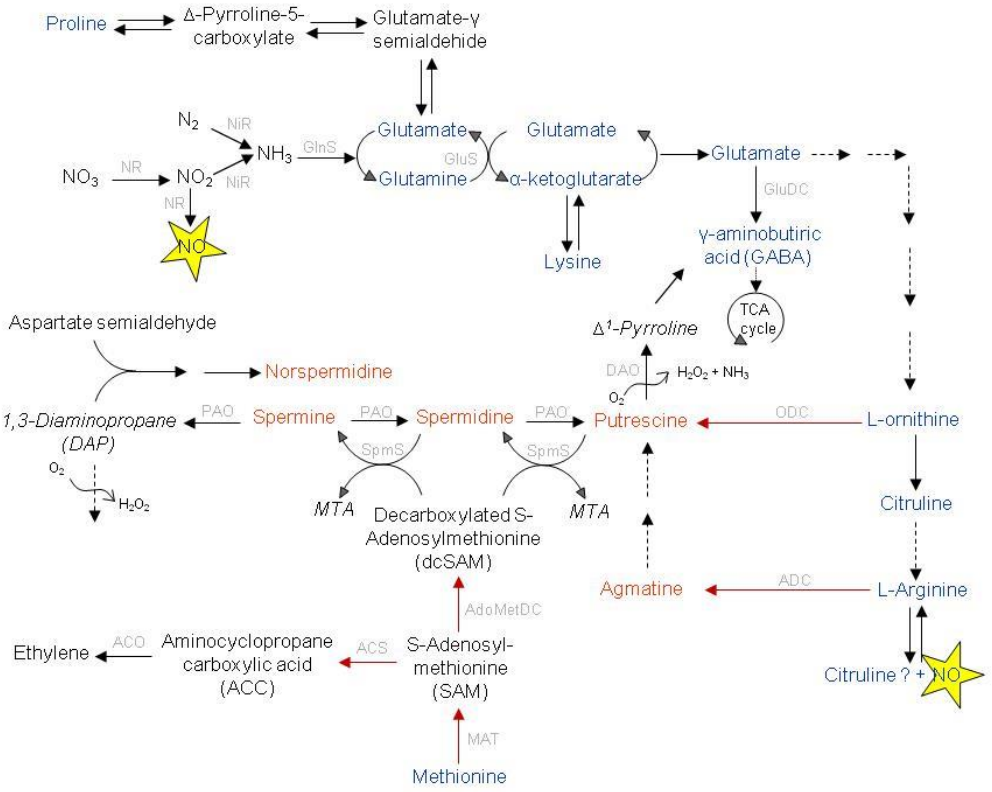


Resistant genotype reduces significantly the Ethylene production respect its control under drought

Next step

In progress… gene expression analysis

-ADC
-ACS
-AdoMetDC
-MAT
-ODC



Contributors:

- Dr. Elena Prats
- PhD. Francisco Canales

- Dr. Luis A.J. Mur

- Simona Cristescu

Thanks for your attention