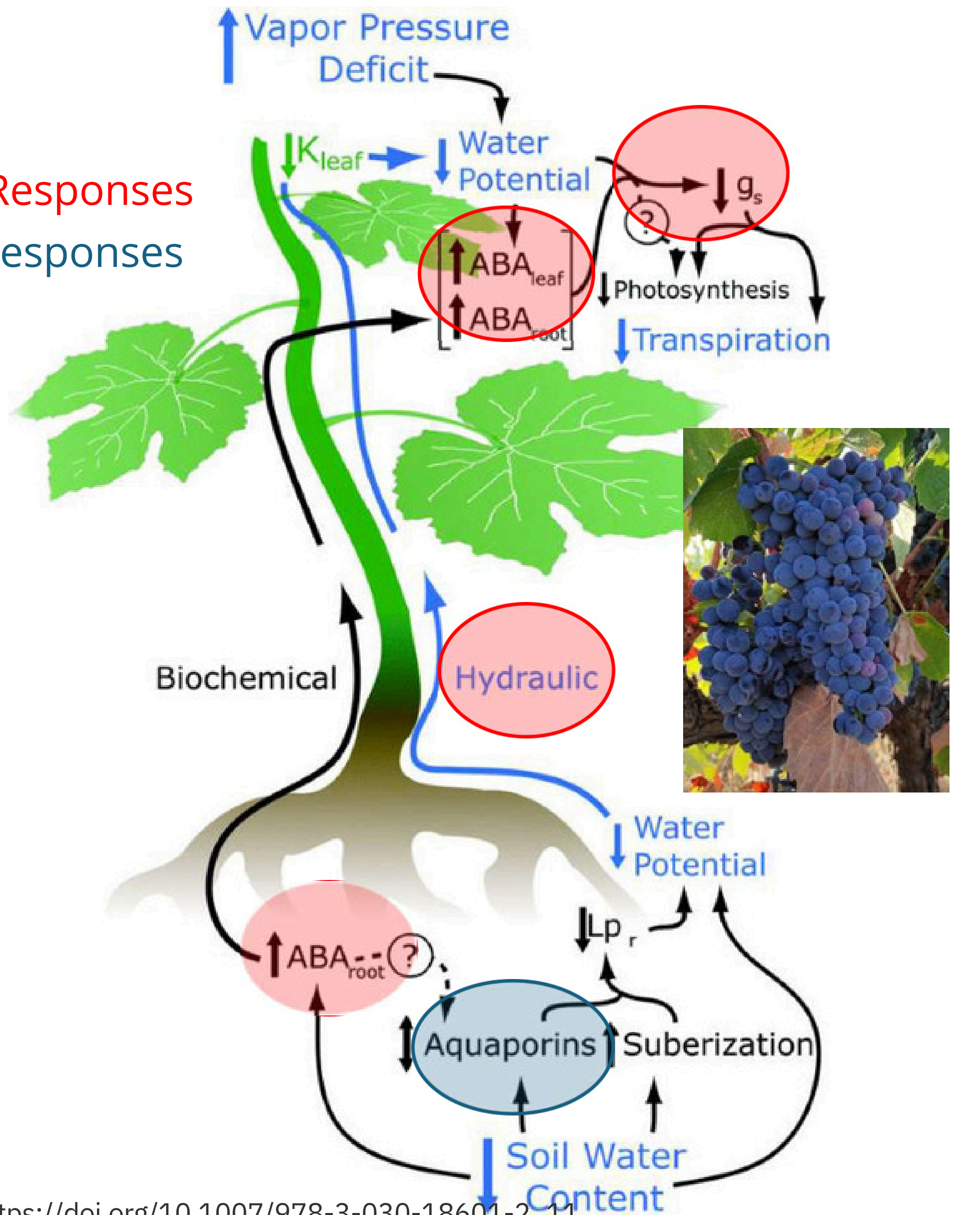
Seasonal dynamics of water and sugar compartmentalization in grape clusters under deficit irrigation

MiguelDamásio, ClaraPinto,JoãodeDeus,TeresaSoares-David, José Silvestre, Luísa Carvalho, OlfaZarrouk

Short-term Responses

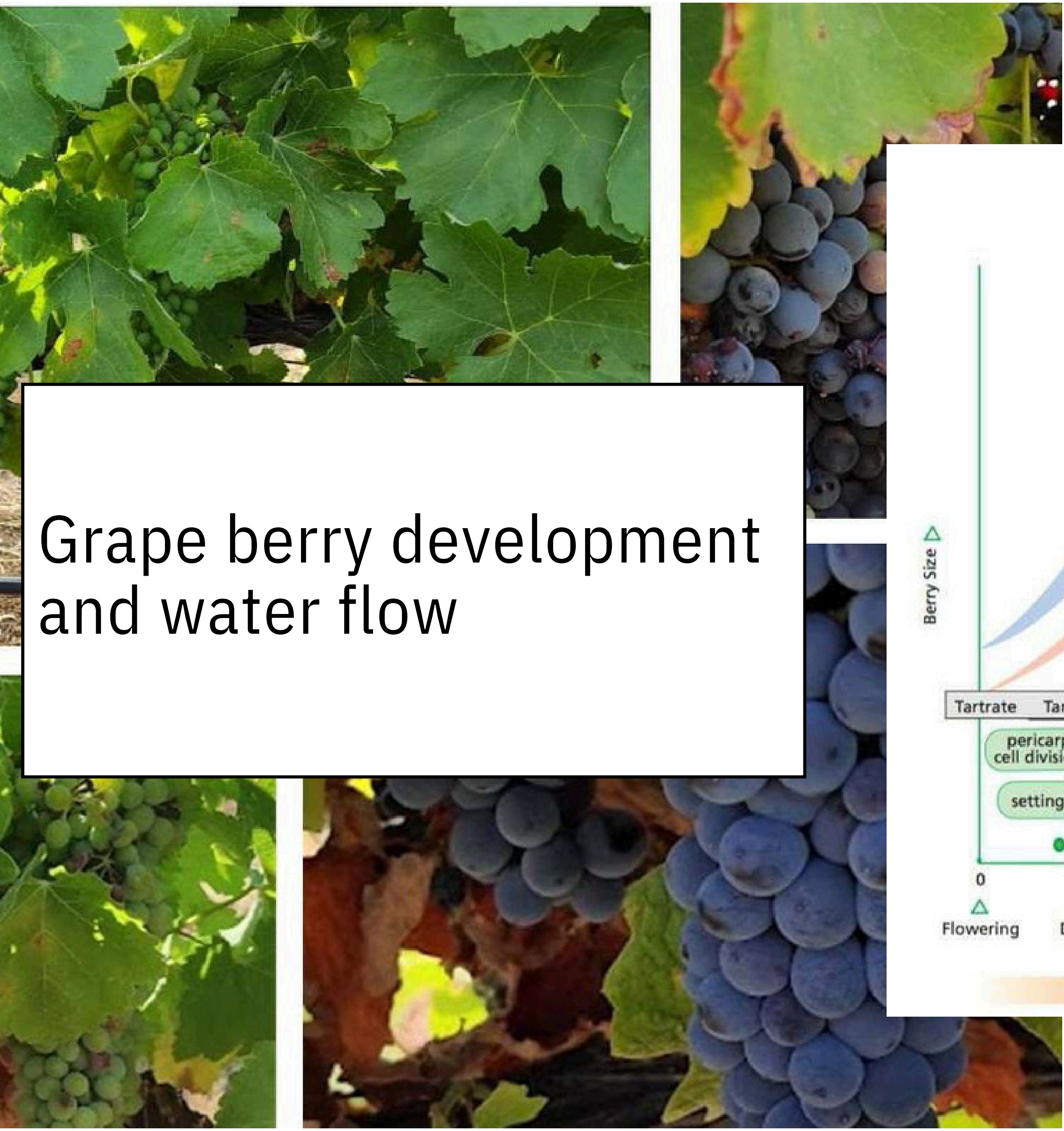
Long-term Responses

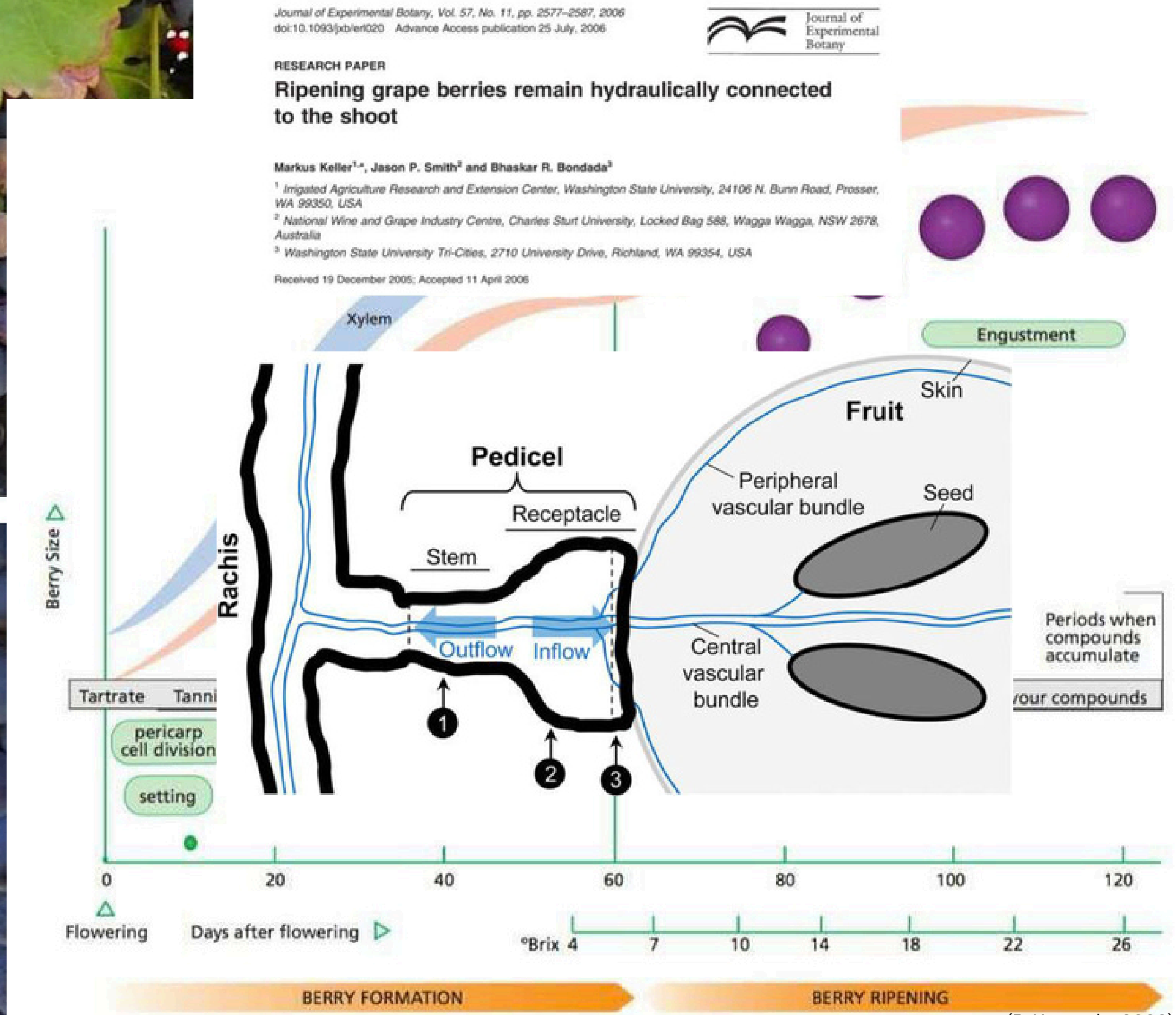


Grapevine response to water stress

Dayeret al., 2019 https://doi.org/10.1007/978-3-030-18601-2_11

Grape berry development and water flow




Journal of Experimental Botany, Vol. 57, No. 11, pp. 2577–2587, 2006
doi:10.1093/jxb/erl020 Advance Access publication 25 July, 2006

RESEARCH PAPER

Ripening grape berries remain hydraulically connected to the shoot

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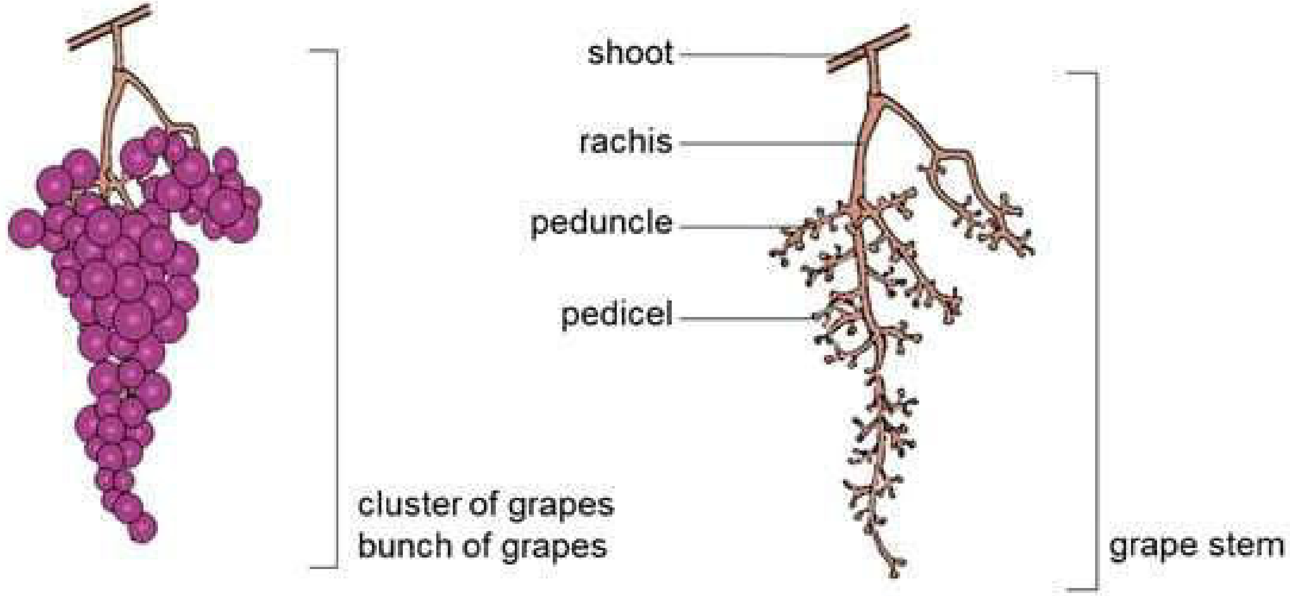
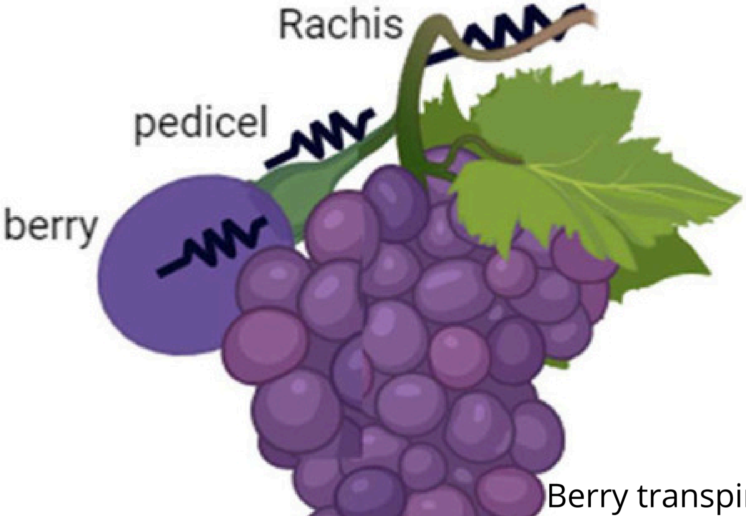
(J. Kennedy, 2002)

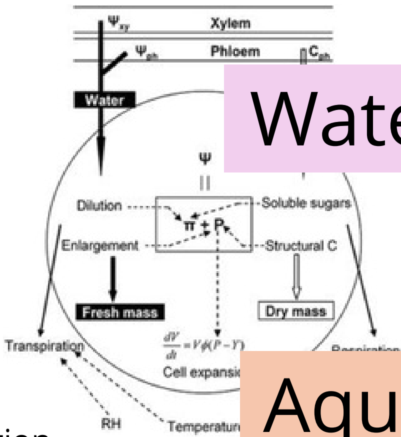
Different compartments



Resistors in the grape cluster



Sugar accumulation

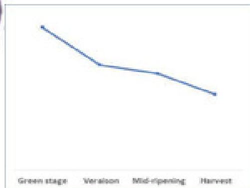


Water stress?

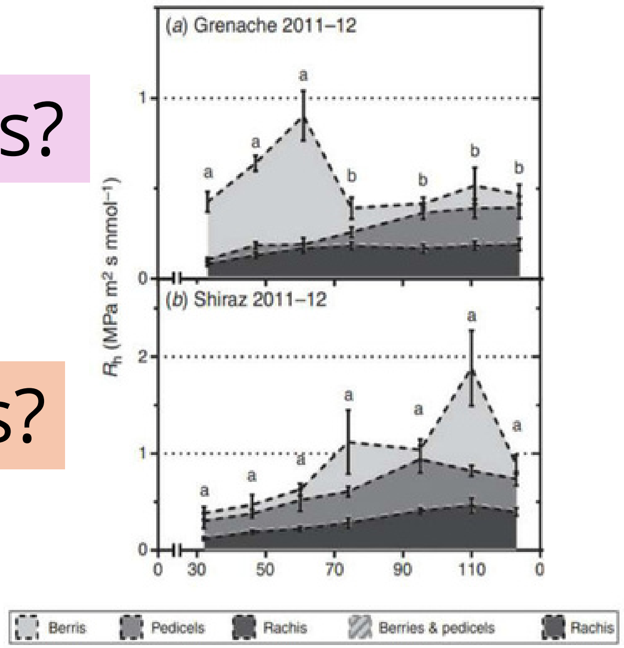
Aquaporins?

Daiet al. 2010

Berry transpiration

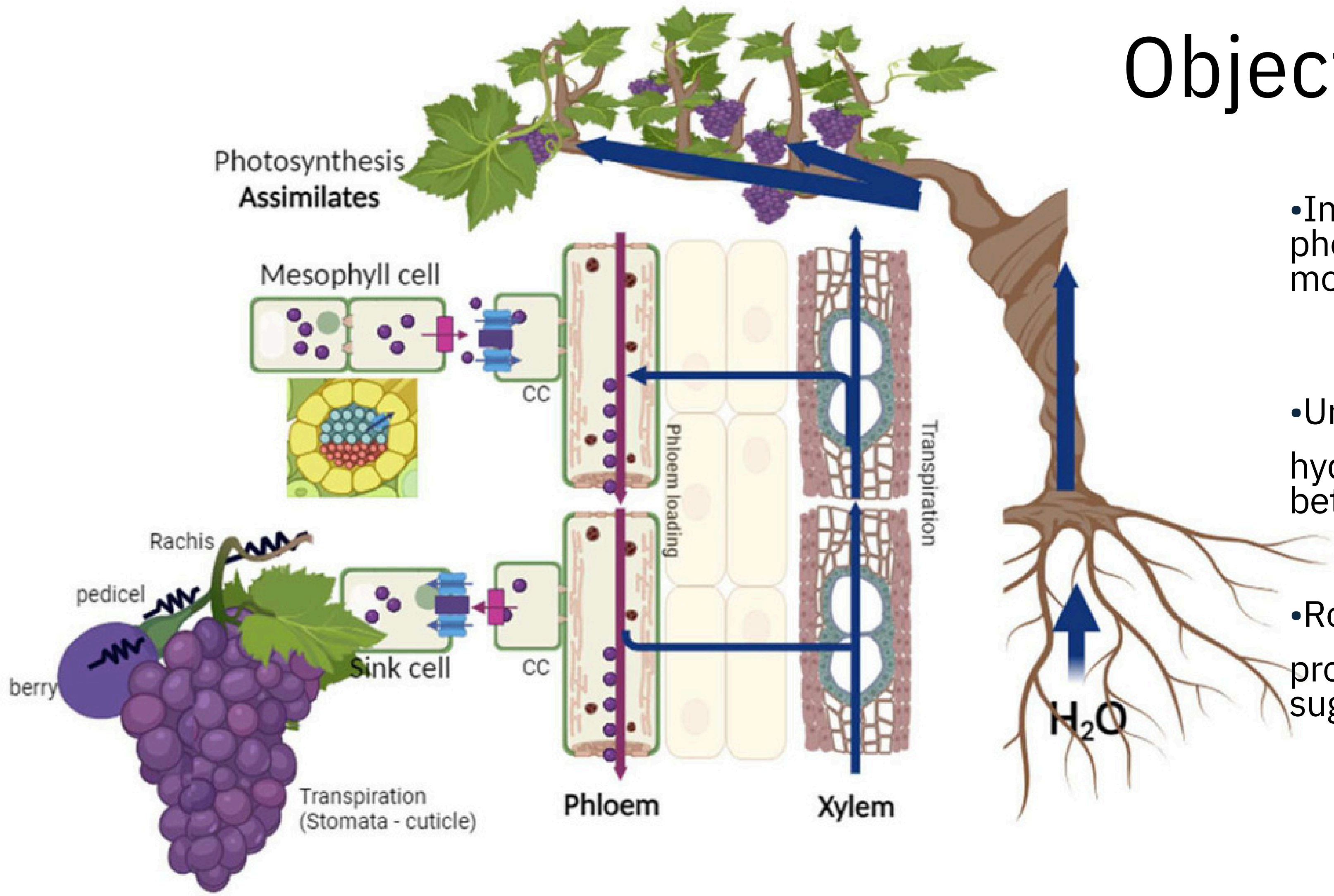


Zarrouk et al. unpublished



Scharwiesand Tyerman, 2016

Objectives



- Impact of vine water status and phenological stage on water movement in berry clusters
- Understand if water stress hydraulic response is coordinated between leaf and berry cluster
- Role of aquaporins in these processes and interaction with sugar pathway

Experimental set up

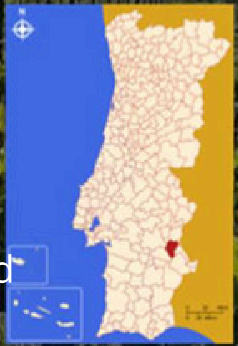
≠ Irrigation Management

For 5 years

- Full irrigation (FI)
  90-100% ETc
- Deficit irrigation (DI)
  50% FI
- No irrigation (NI)
  Rain-fed

Touriga Nacional/P1103

Syrah/P1103



Hot and dry summers and mild rainywinters

Procedures

Pepper-corn size (PCS)

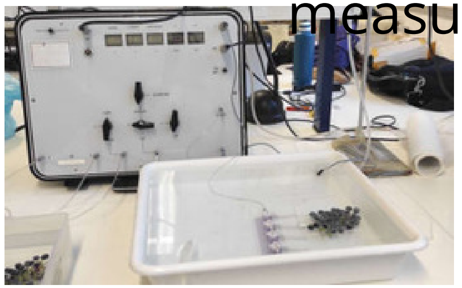
Pea Size (PS)

Véraison (VER)

Full-maturation (FM)

Field measurements

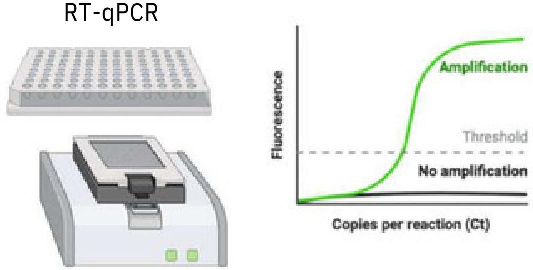

Hydraulic measurements



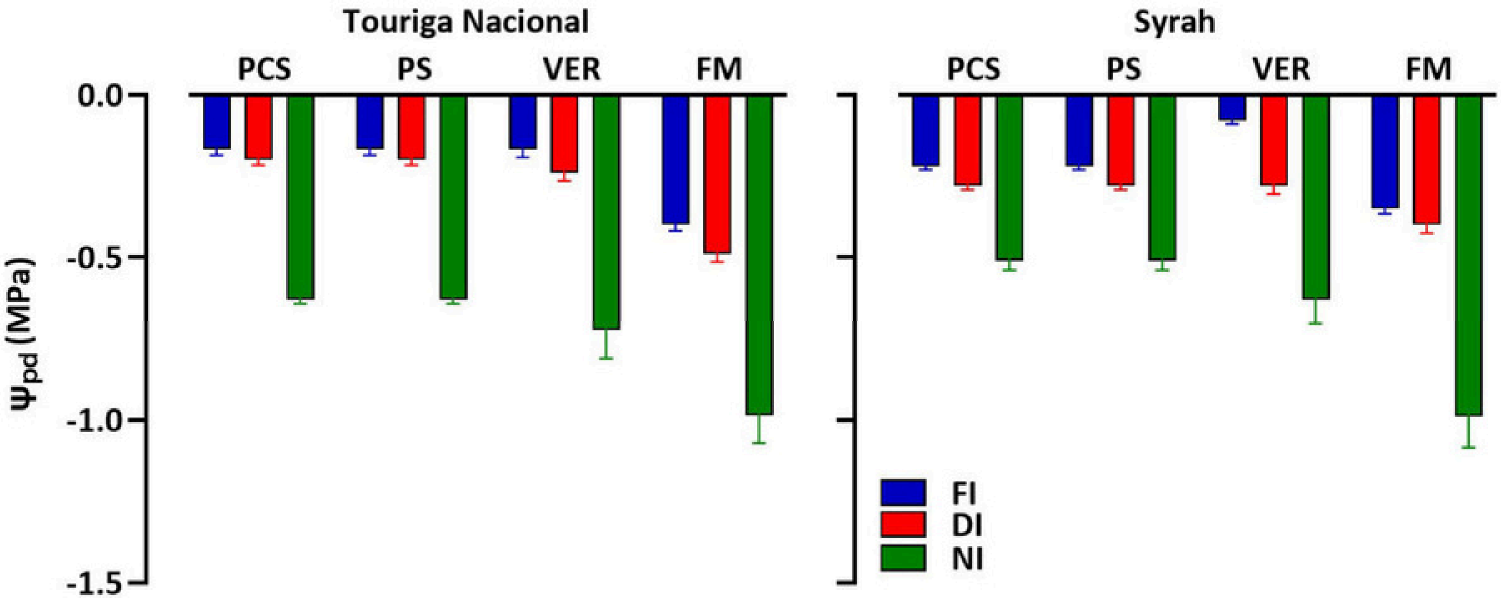
Aquaporinsandsugar transportersgene expressions

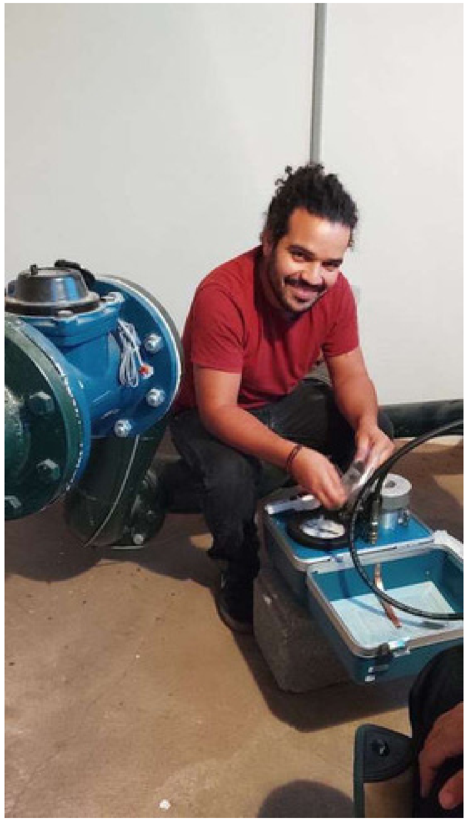
PIP1s
PIP2s
TIP1s
TIP2s
SWEETs
GIN1
HTs
TMTs

RT-qPCR



Predawn Leaf Water Potential



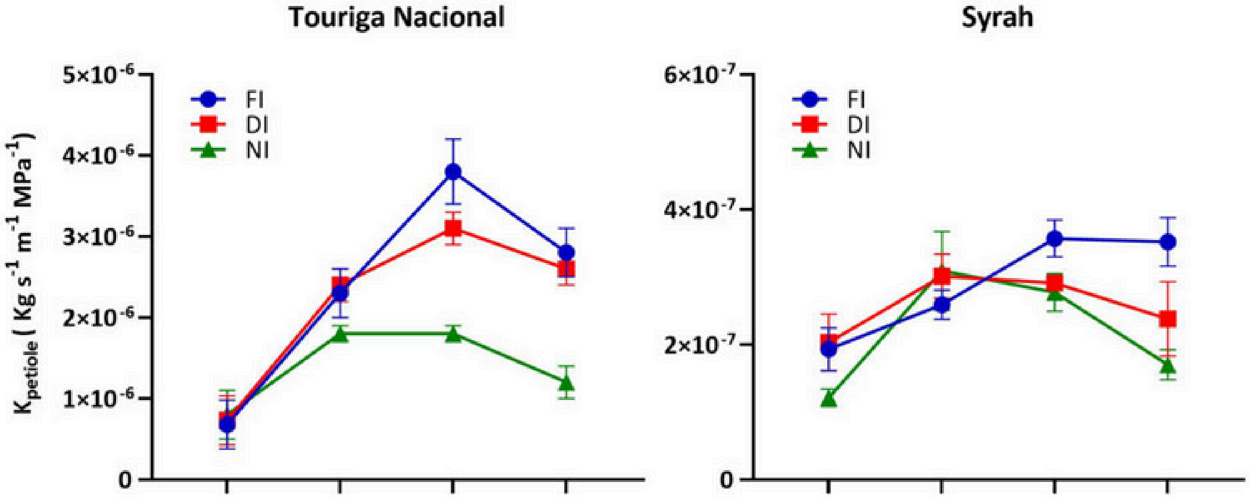


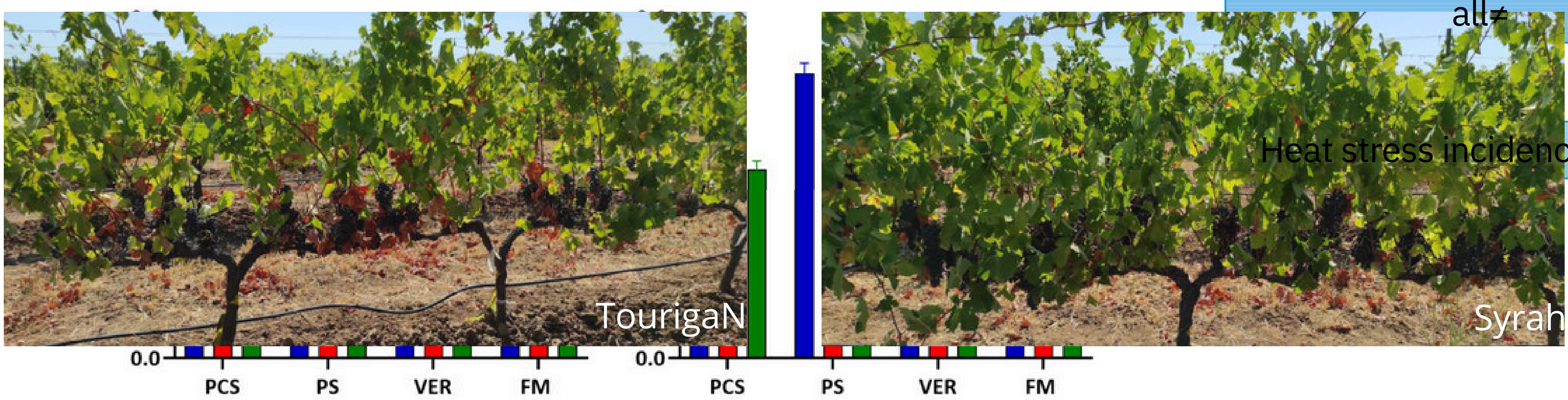
FI ≈ DI

NI ≠ all

ψpdSyrah >Ψ_{pd} Touriga Nacional

Leaf Hydraulics



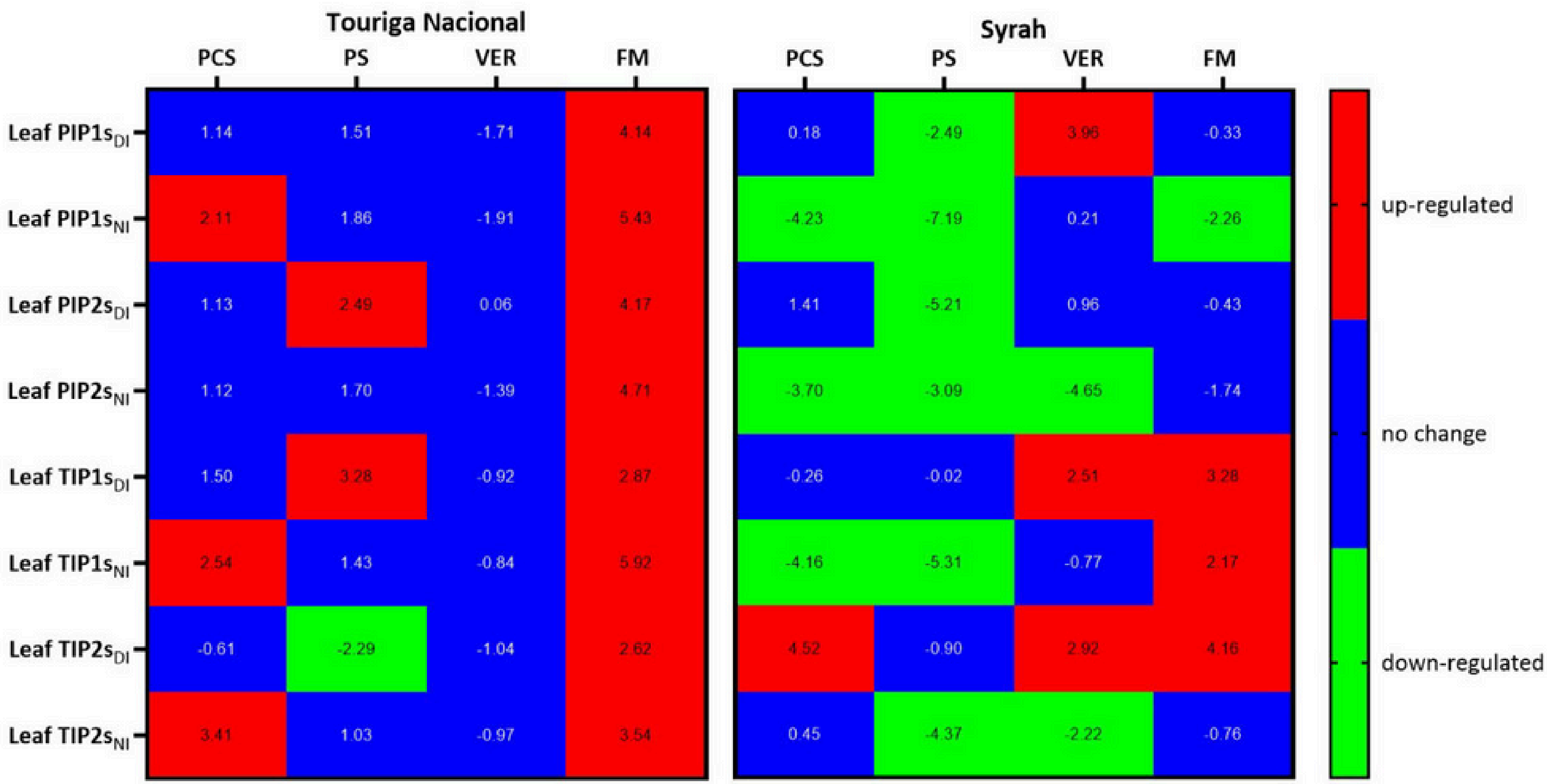


Different hydraulic strategies

Hydraulic conductivity
FI ≈ DI
NI ≠ all
Stomatal conductance
all≠

Heat stress incidence > Syrah

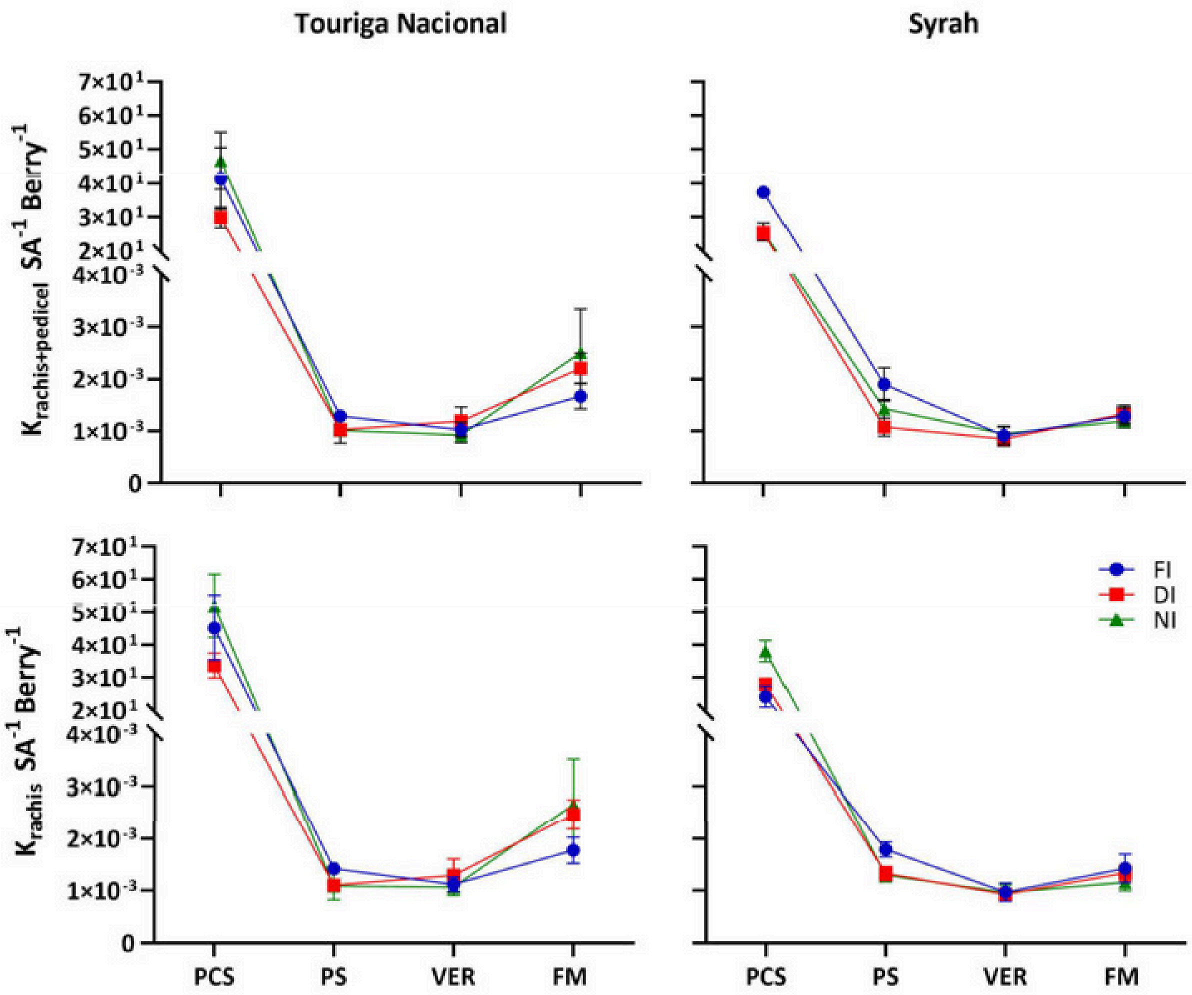
Leaf aquaporins



TourigaNacional ≠ Syrah

Down-regulationofAQPsin Syrah butnotin TourigaNacional

Cluster Hydraulics

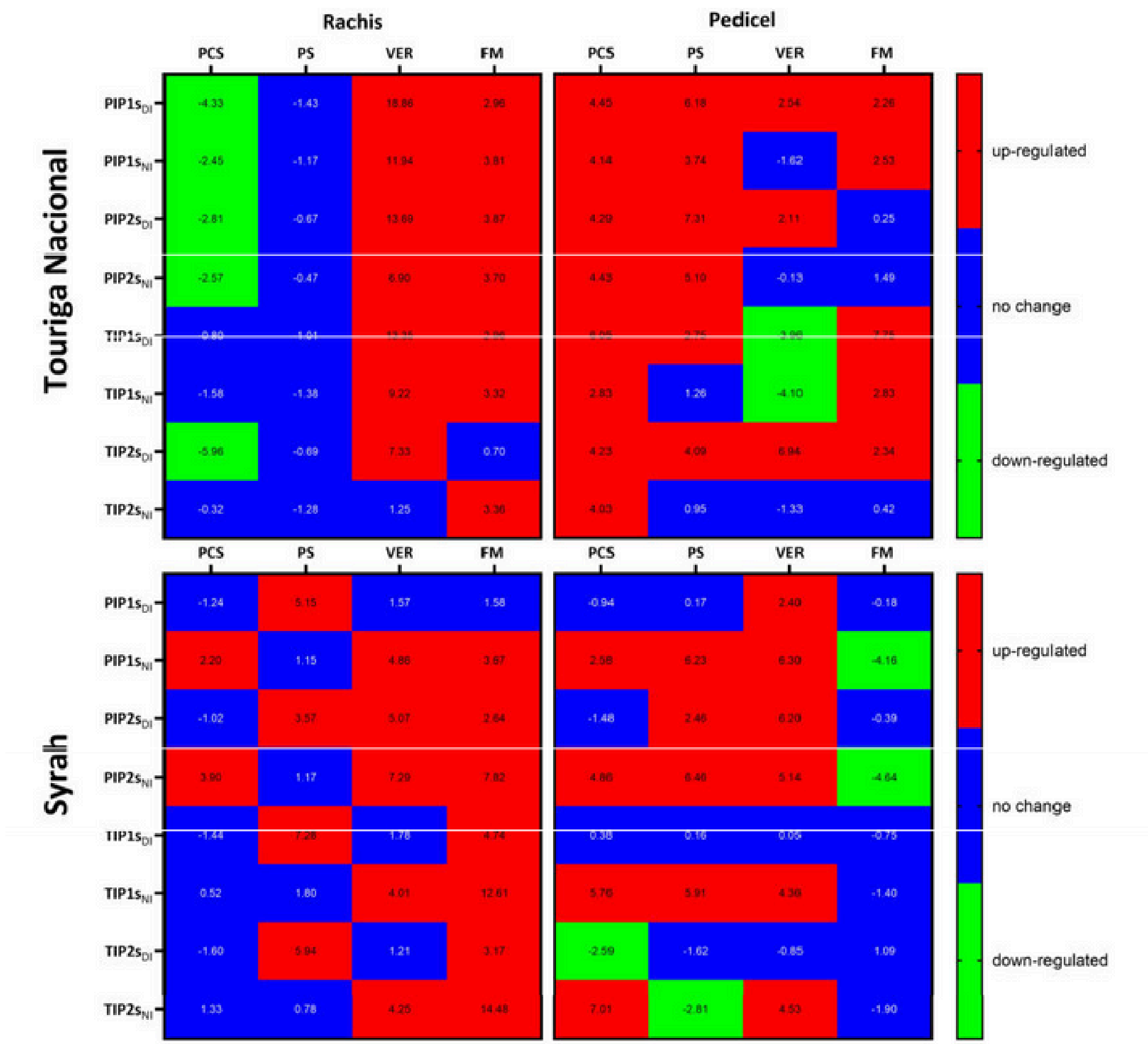


BERRY GROWTH PROGRAM CONSERVED MECHANISM

Sharp decrease of K after PCS

K increaseafterveraison lessin Syrah

Berrycluster aquaporins



Touriga Nacional

- Up-regulationatVER andFM in rachis and pedicel

Syrah

- Up-regulationatVER in rachisand pedicelandonlyin RachisatFM

Take home messages

• Cluster hydraulic conductivity is conserved vs. leaves and peaks before the lag phase.
•Touriga Nacional shows higher xylem demand and aquaporin upregulation at cluster level □ cultivar-specific response.
•Syrah shows limited aquaporin regulation □ different multistress strategy response.
• Aquaporins are key in cluster water homeostasis.
• Genotypic plasticity impacts water use □ irrigation should be tailored to cultivar needs to match its phenology-dependent water demands.

FruitCREWS

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(INIAV)

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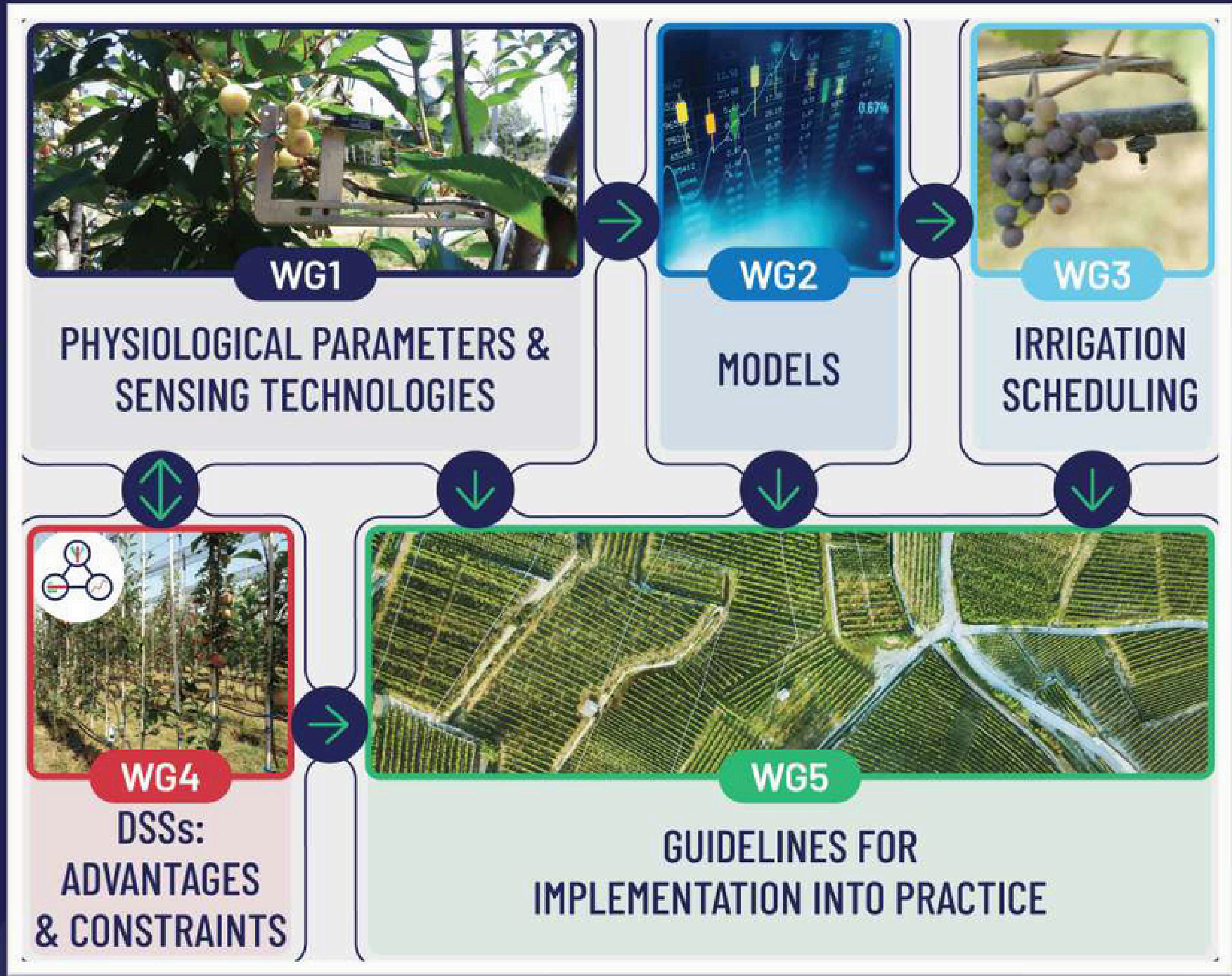
FruitCREWS



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