PIEMONTE

REGIONE PIEMONTE

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# LA RISORSA IDRICA IN PIEMONTE

## LE STRATEGIE DI GESTIONE IDRICA IN AGRICOLTURA

*Scenari, deficit idrici, politiche pubbliche e progetti innovativi:*
*confronto tra Piemonte e Israele*

Mercoledì 1 marzo 2023
International Training Centre of the ILO

**Stress idrico e bilancio del carbonio nella vite e colture arboree**

**Claudio Lovisolo,**
**DISAFA, Università degli Studi di Torino**

*The Plant Journal (Wiley)* https://doi.org/10.1111/tpj.16000

# Photosynthetic recovery in drought-rehydrated grapevines is associated with high demand from the sinks, maximizing the fruit-oriented performance.

Davide L. Patono[1], Daniel Said-Pullicino[1], Leandro Eloi Alcatrão[1], Andrea Firbus[1], Giorgio Ivaldi[1], Walter Chitarra[2,3], Alessandra Ferrandino[1], Davide Ricauda Aimonino[1], Luisella Celi[1], Giorgio Gambino[2], Irene Perrone[2], Claudio Lovisolo[1,2,*]

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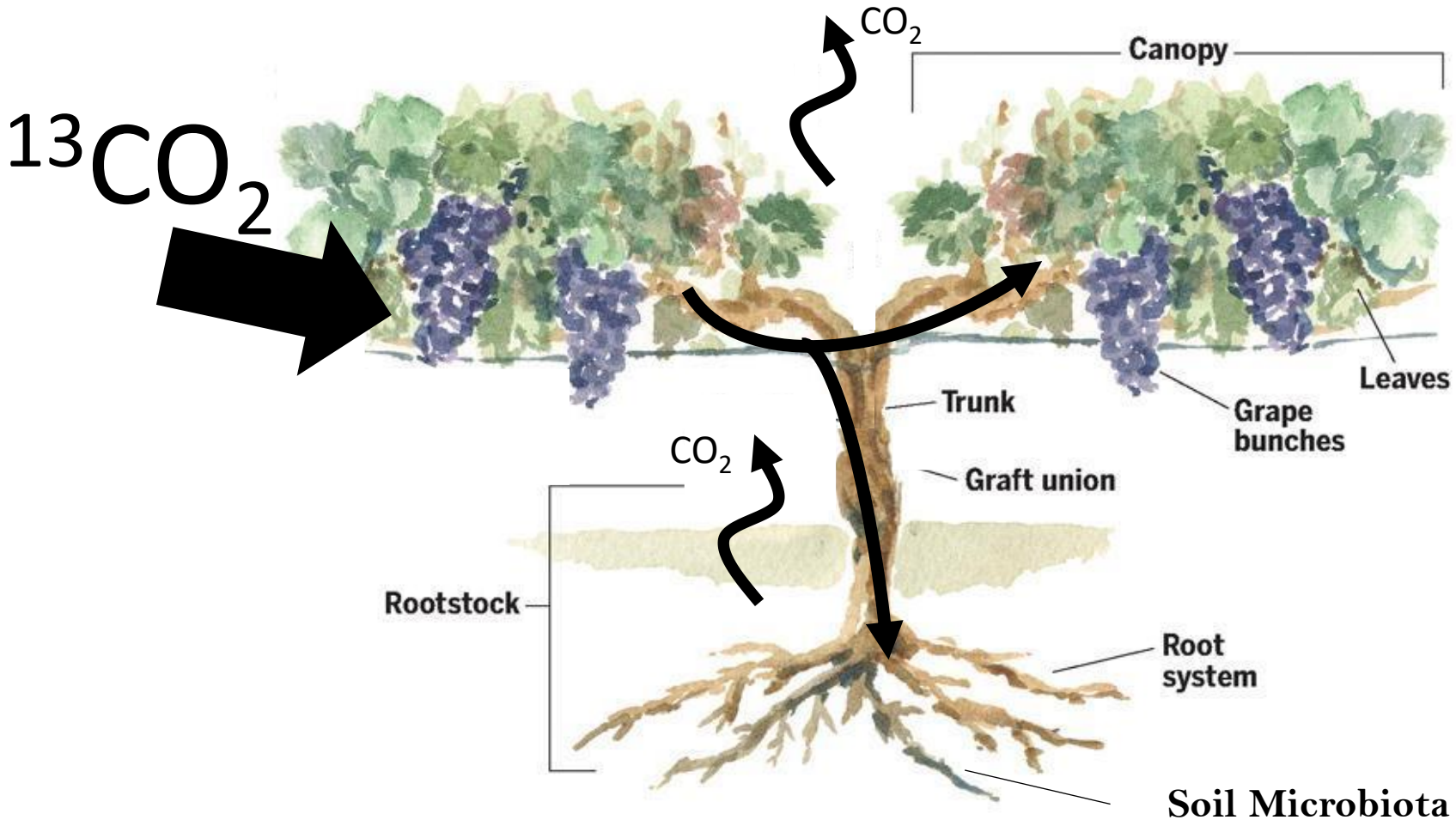
La disponibilità di acqua e le temperature influenzano la dinamica del carbonio.

La vite è una pianta che si adatta a periodi di siccità, situazione d'induzione di qualità degli acini.

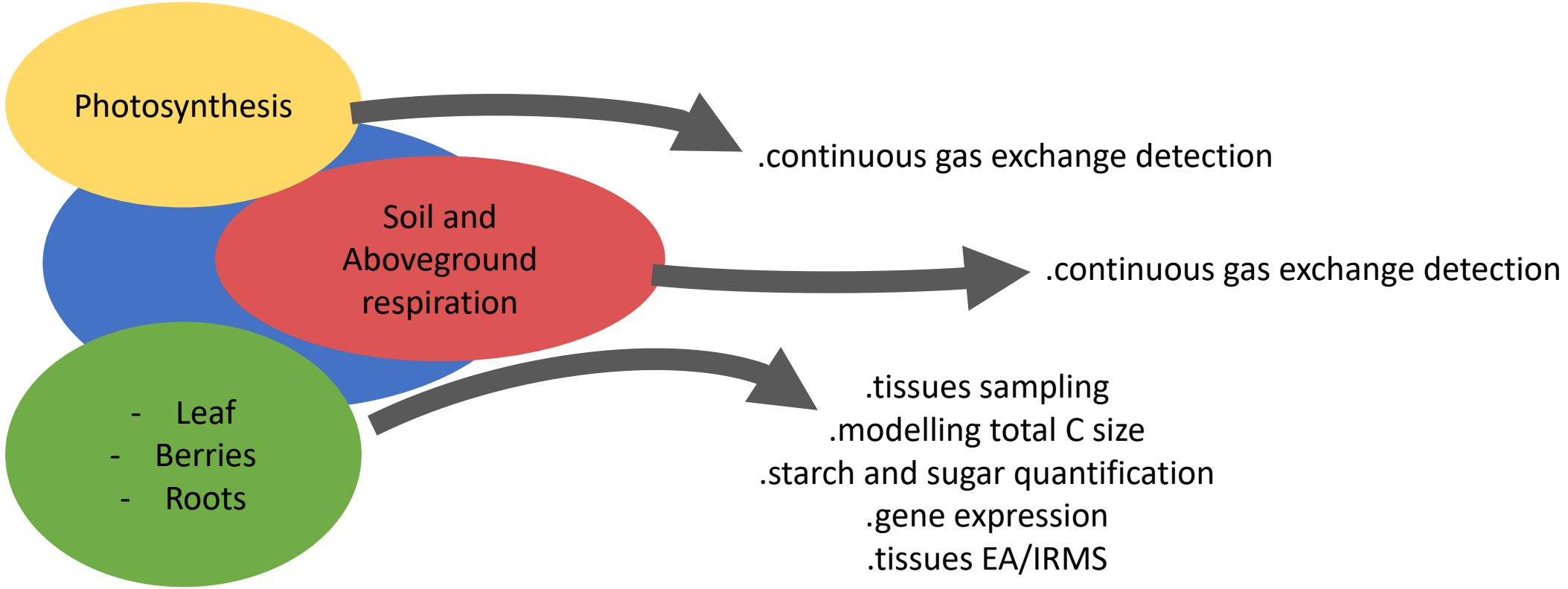
Nelle piante la radice orchestra gli adattamenti alla siccità, fungendo da accumulatore del carbonio allocato durante i rallentamenti della crescita.

Nella vite le radici competono con i grappoli nel ricevere i fotosintetati e la competizione aumenta con lo stress idrico.

# Pulse-chasing isotopic strategy to study the allocation kinetics of carbon in the different sinks competing in grapevines



# CARBON BALANCE




$$C\ allocated = {}^{13}C\ excess \cdot C\ pool\ size$$

# continuous gas exchange detection between plants / soil and atmosphere

*accepted for publication to Plant Science (Elsevier)* https://doi.org/10.1016/j.plantsci.2022.111505

# Technical advances for measurement of gas exchange at the whole plant level: design solutions and prototype tests to carry out shoot and rootzone analyses in plants of different sizes.

Davide L. Patono[1], Leandro Eloi Alcatrão[1], Emilio Dicembrini, Giorgio Ivaldi[1], Davide Ricauda Aimonino[1], Claudio Lovisolo[1,2,*]

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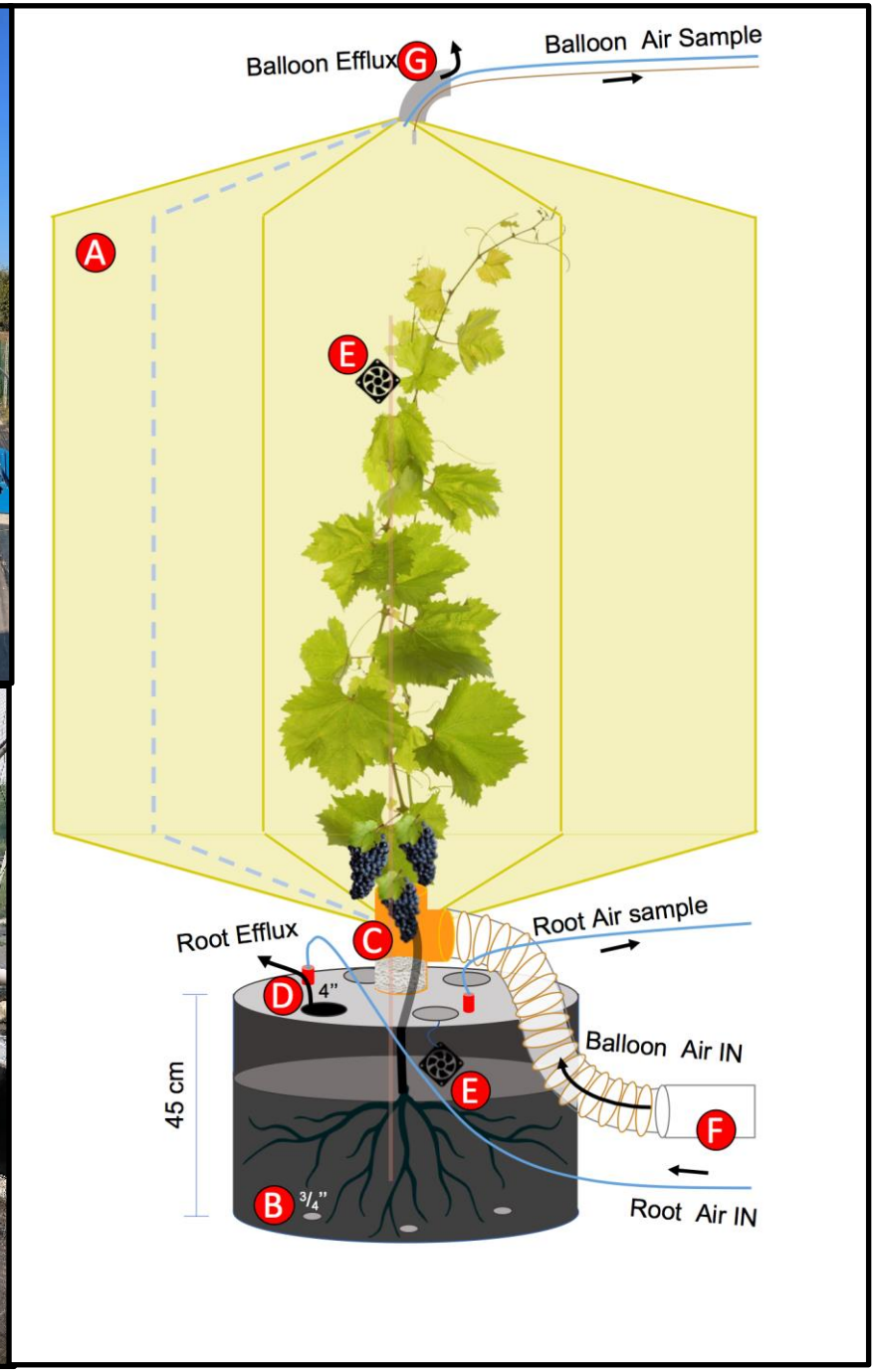
[2]Institute for Sustainable Plant Protection, National Research Council, Turin, Italy
[*]Corresponding author

Prototype 1

small plants

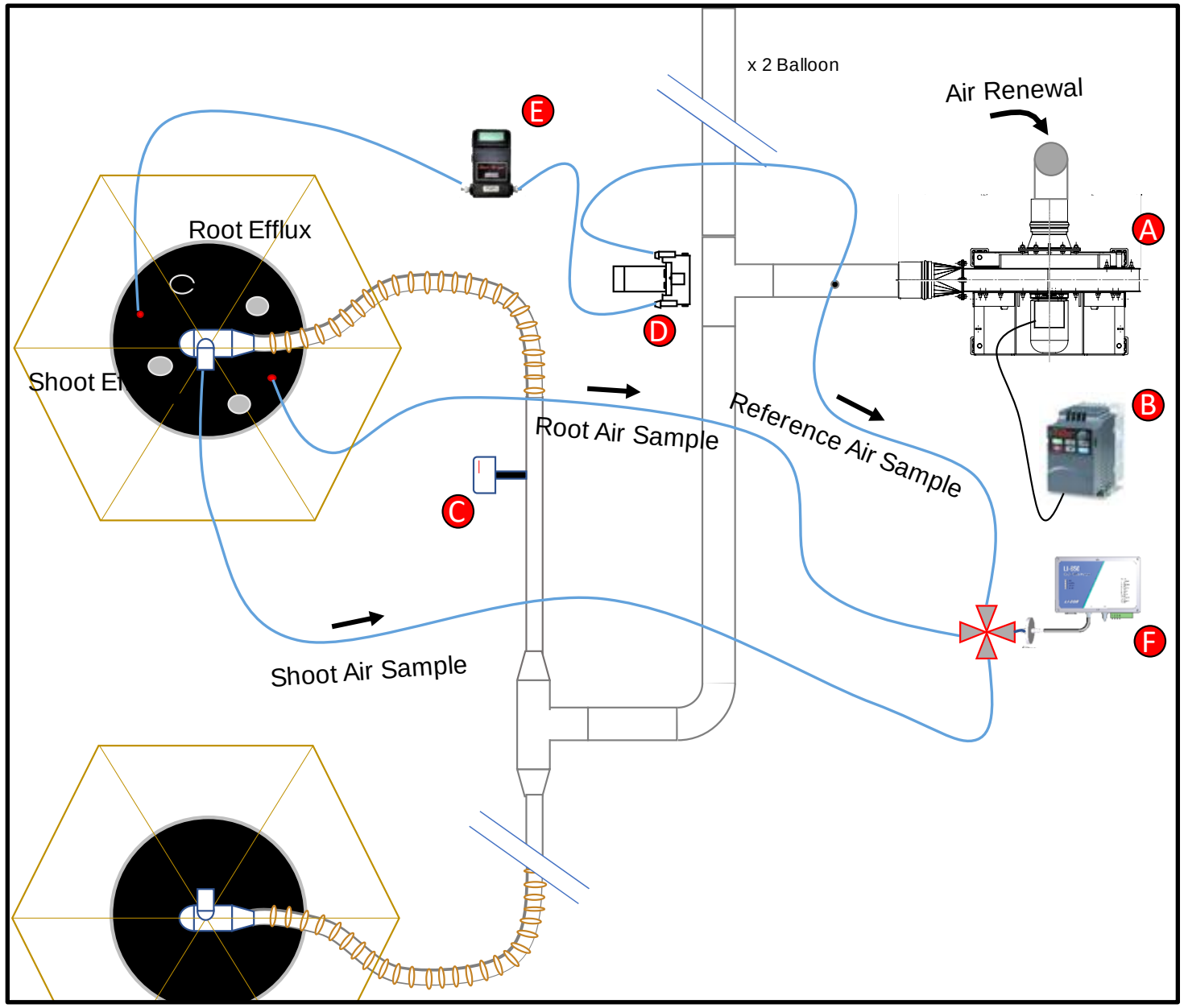
Prototype 2

large plants



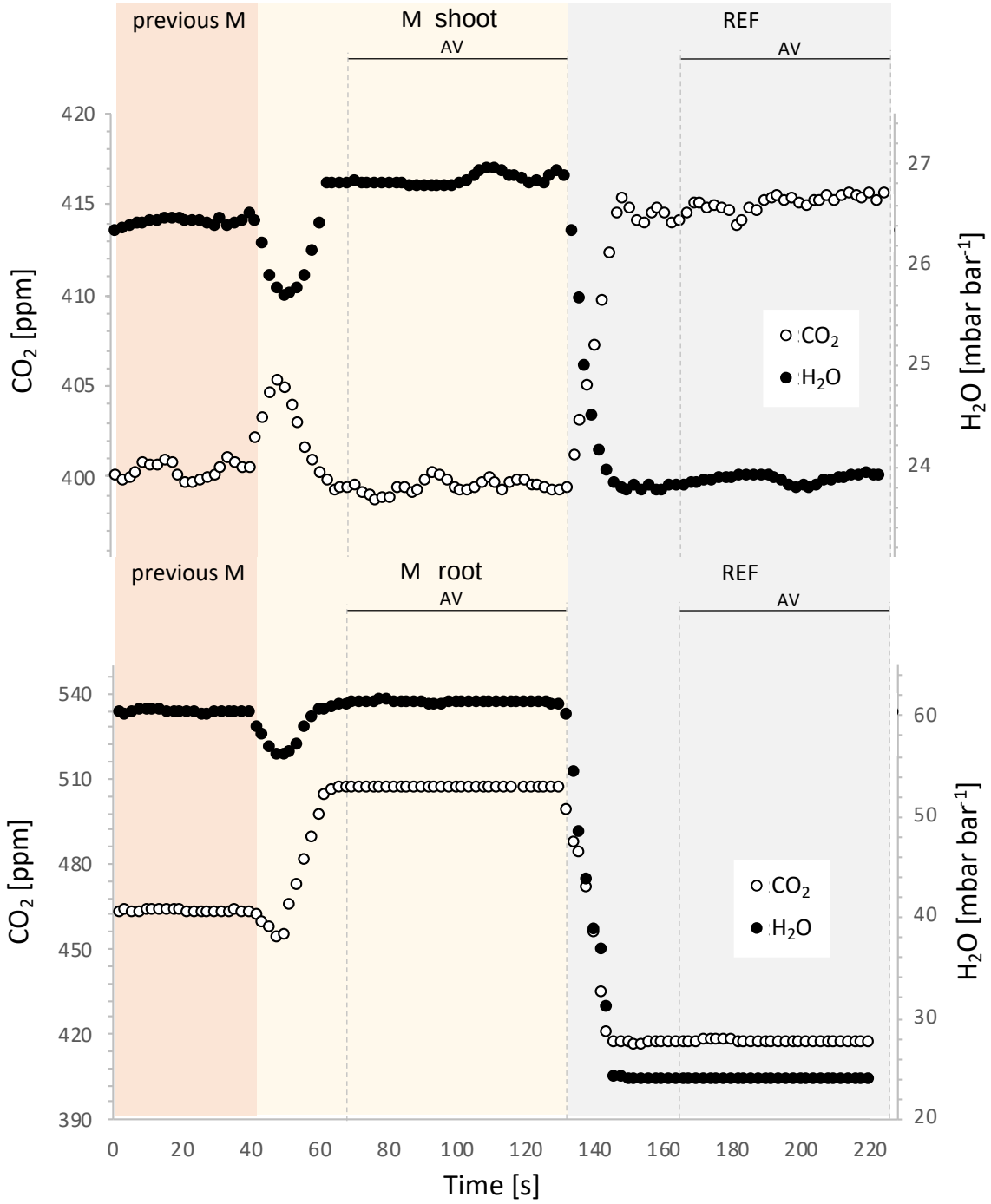

## Prototype 2
## photosynthesis and respiration analysis mimicking natural environment

- A Baloon (shoot cuvette)
- B Root cuvette
- C PVC T
- D Holes for root sampling
- E Fans
- F Air in
- G Air out




## Prototype 2
## photosynthesis and respiration analysis mimicking natural environment

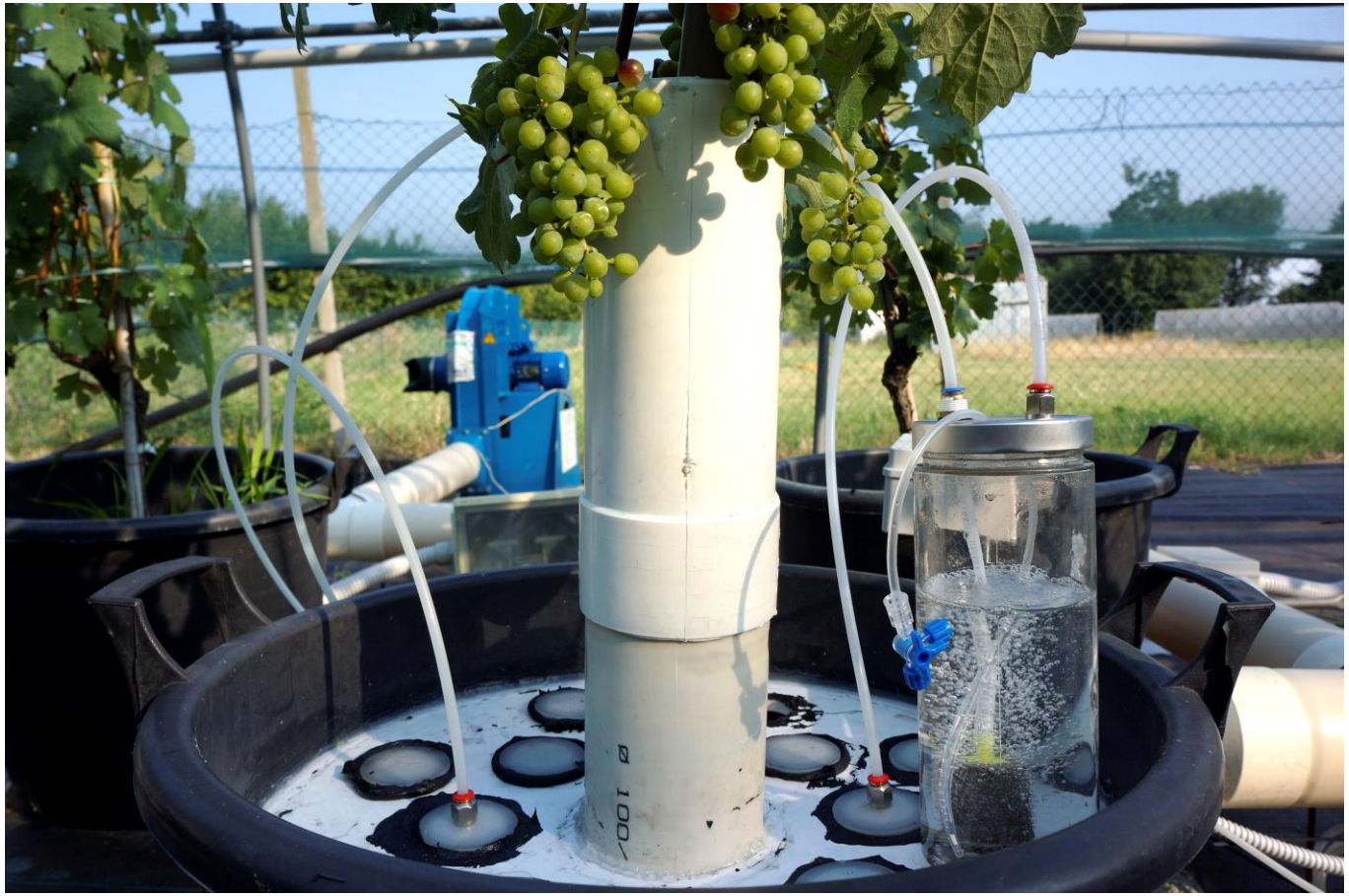
- A Centrifugal blower
- B Inverter
- C Air velocity sensor
- D Diaphragm pump
- E Flow meter
- F IRGA

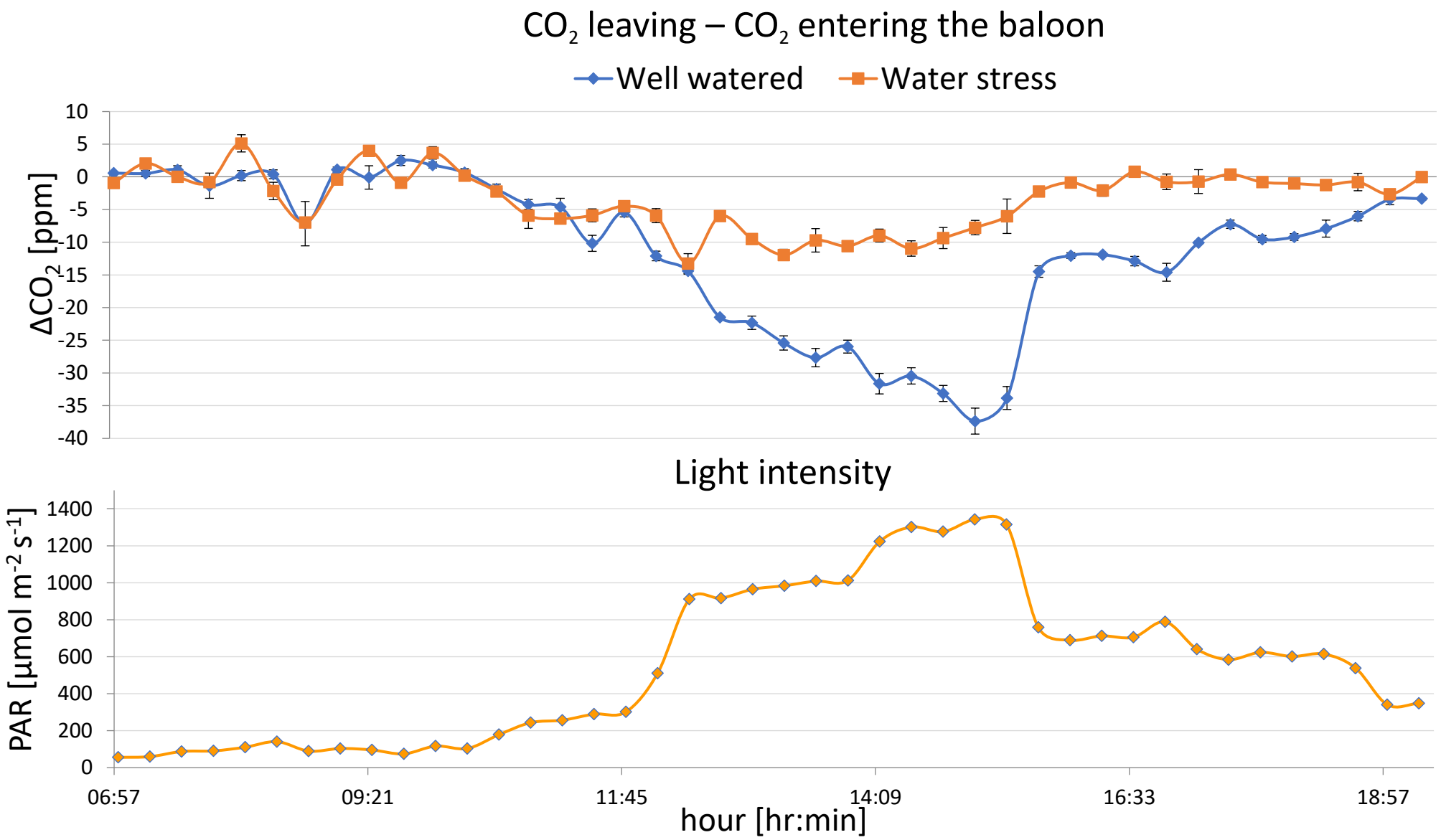



Prototype 2
photosynthesis and respiration analysis
mimicking natural environment

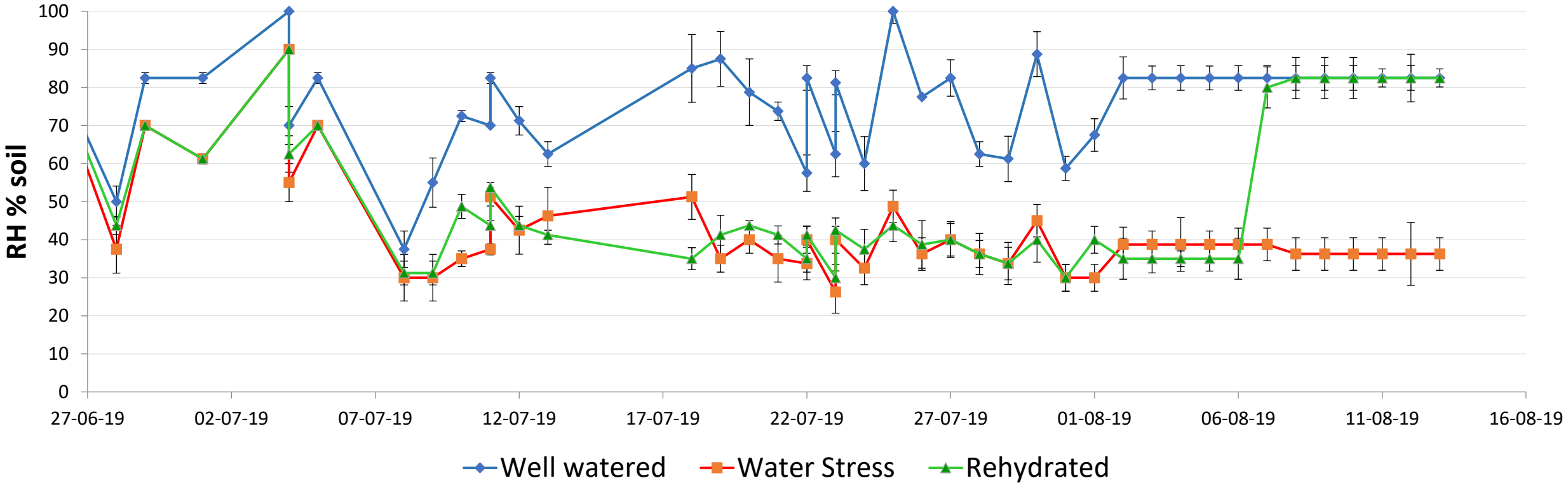
Measurement routines

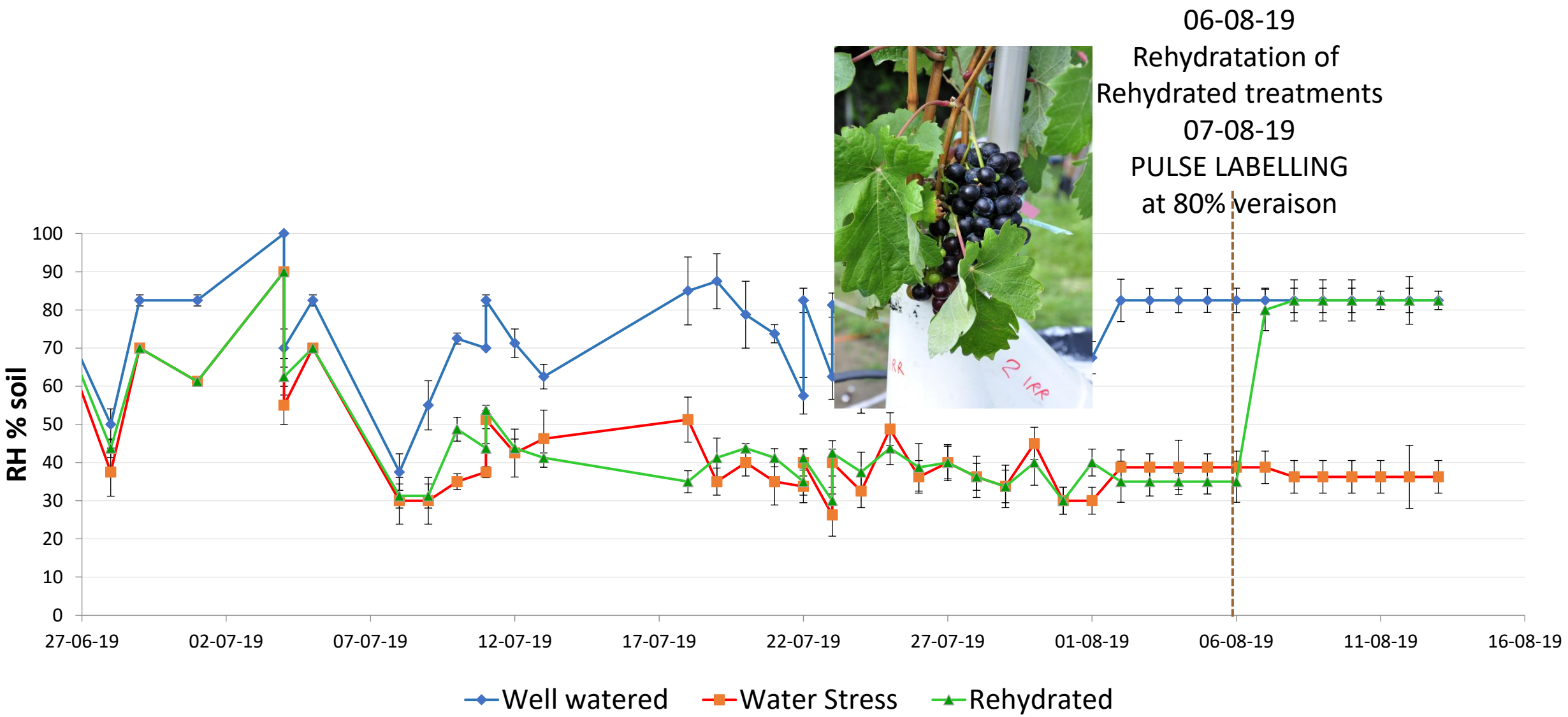
# continuous gas exchange detection between plants / soil and atmosphere

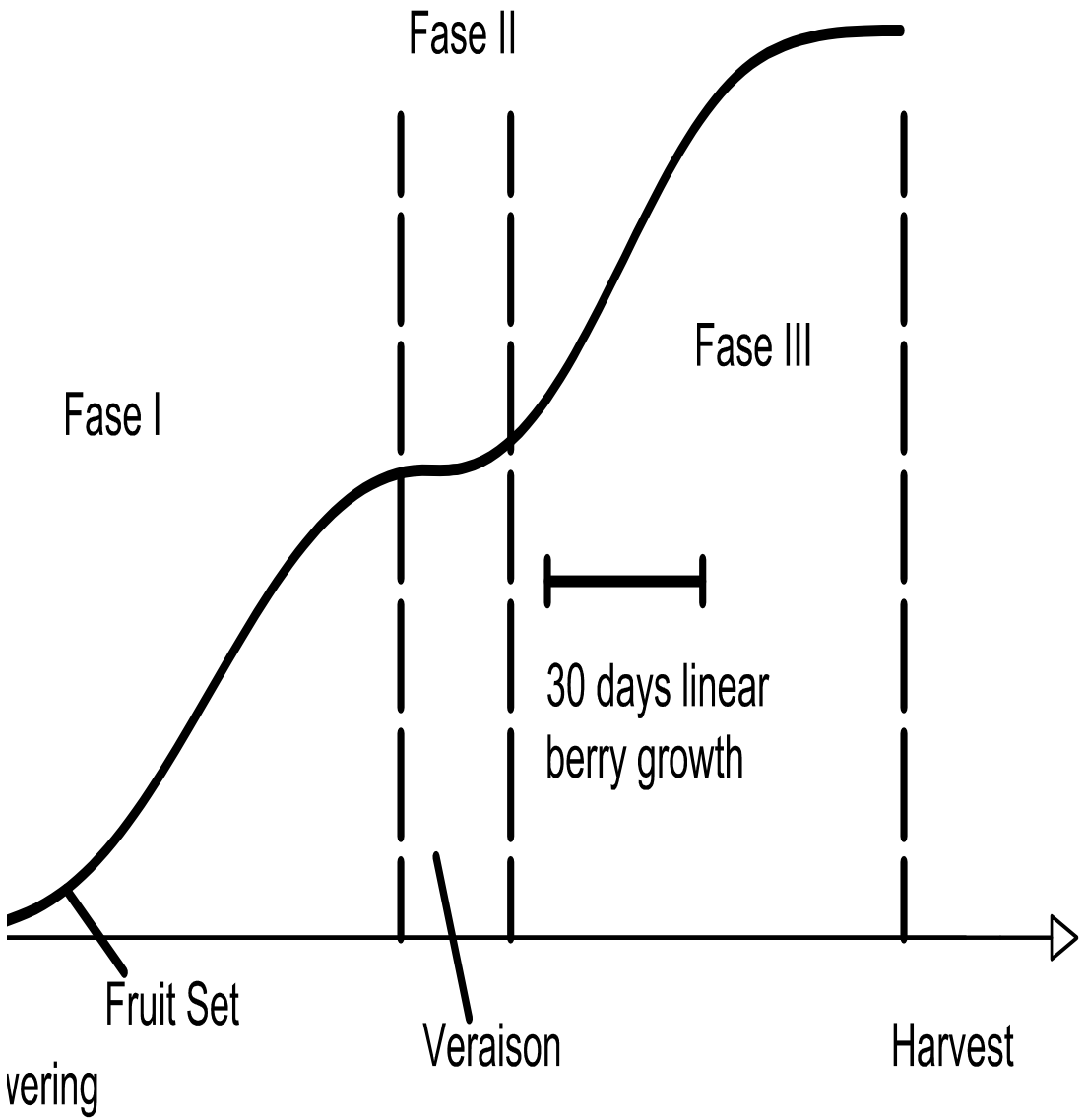



$CO_2$ leaving – $CO_2$ entering the baloon
Well watered
Water stress
$\Delta CO_2$ [ppm]
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
Light intensity
PAR [µmol $m^{-2}$ $s^{-1}$]
1400
1200
1000
800
600
400
200
0
06:57
09:21
11:45
14:09
16:33
18:57
hour [hr:min]

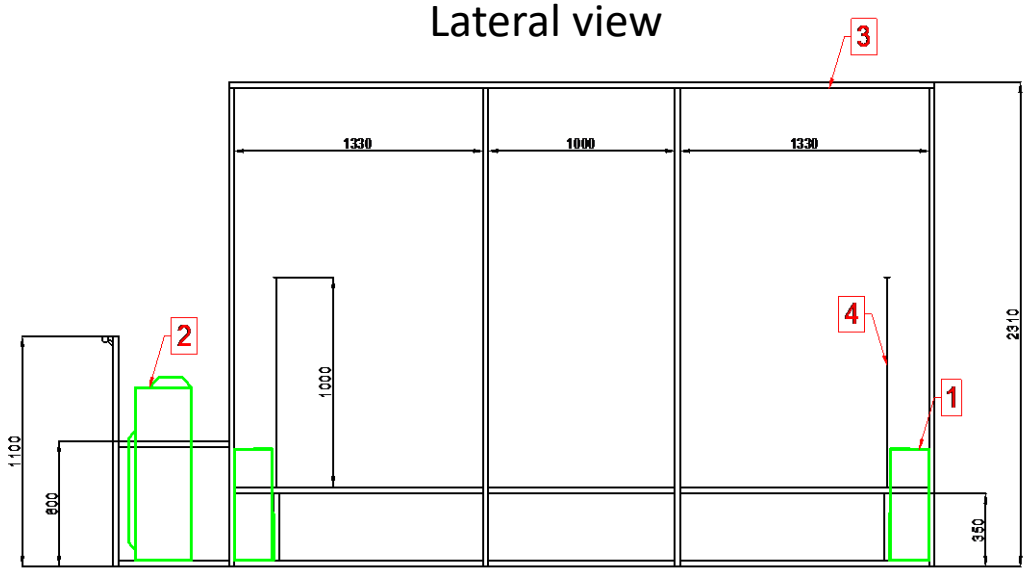
- 3 treatments: Well watered, Water stress and Rehydrated



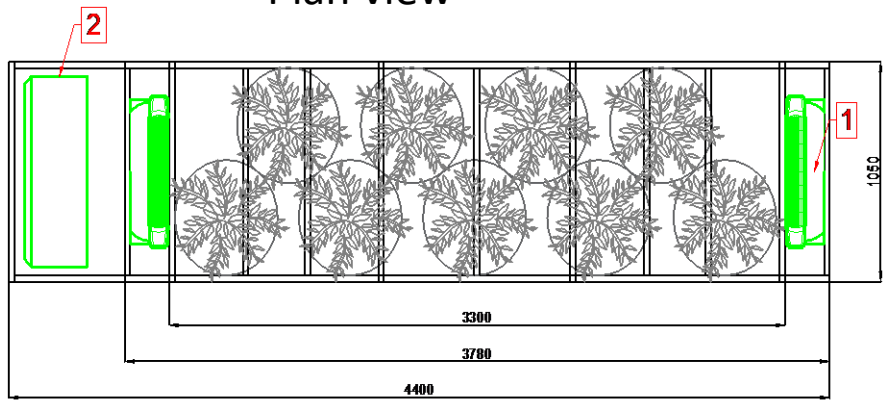

06-08-19
Rehydratation of
Rehydrated treatments
07-08-19
PULSE LABELLING
at 80% veraison
RH % soil
100
90
80
70
60
50
40
30
20
10
0
27-06-19
02-07-19
07-07-19
12-07-19
17-07-19
22-07-19
27-07-19
01-08-19
06-08-19
11-08-19
16-08-19
Well watered
Water Stress
Rehydrated


Fase II
Fase III
Fase I
30 days linear
berry growth
Fruit Set
Veraison
Harvest
vering

Lateral view




Plan view



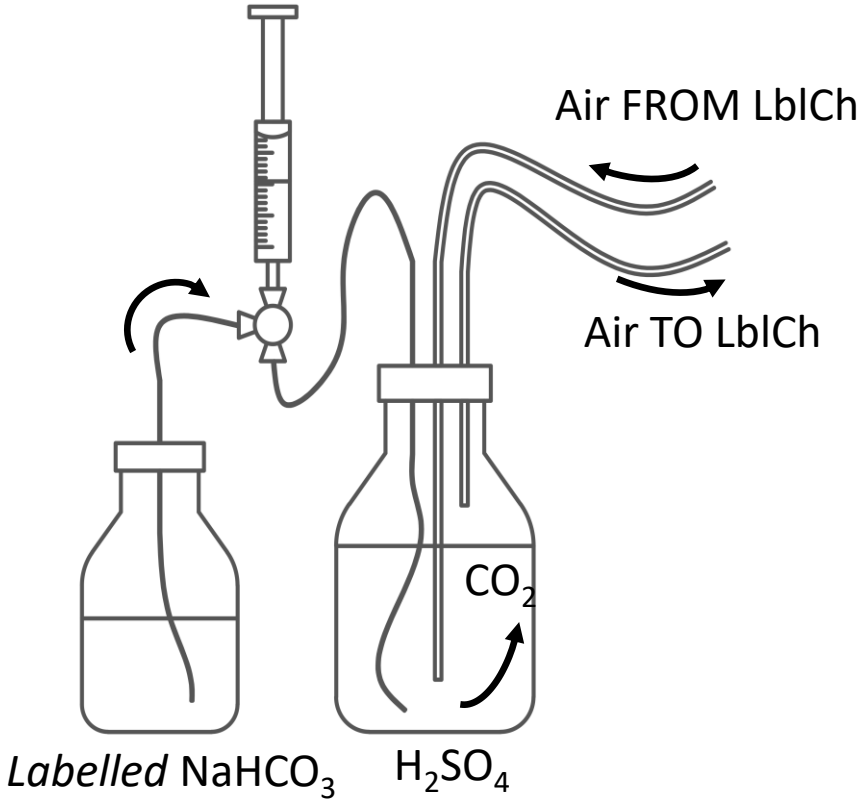

Controlling:

LIGHT INTENSITY

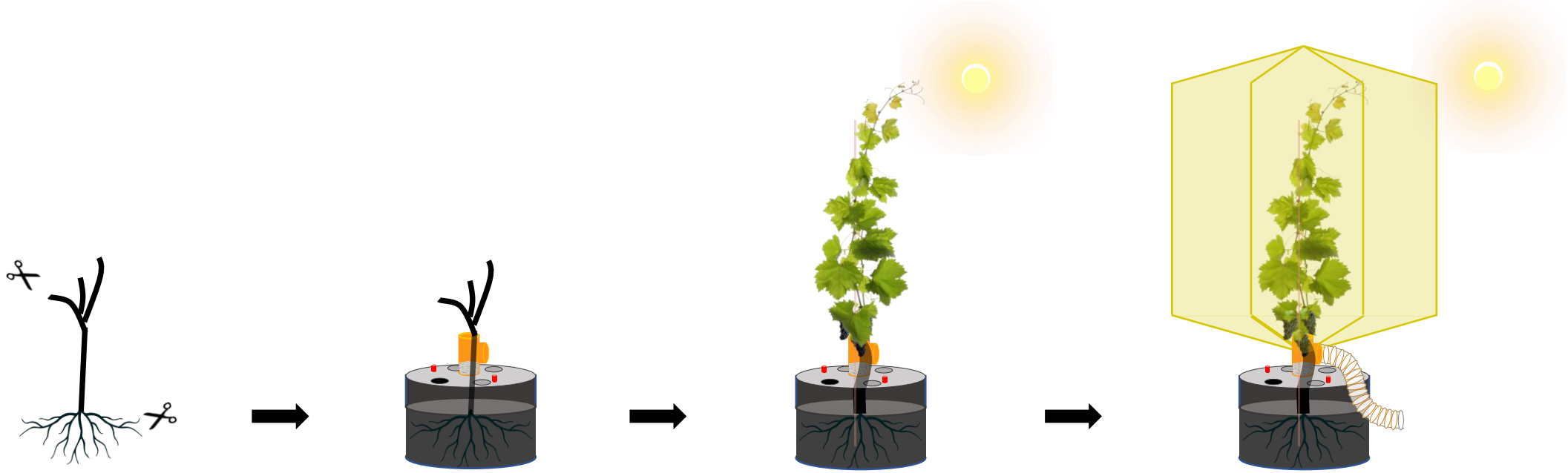
AIR TEMPERATURE

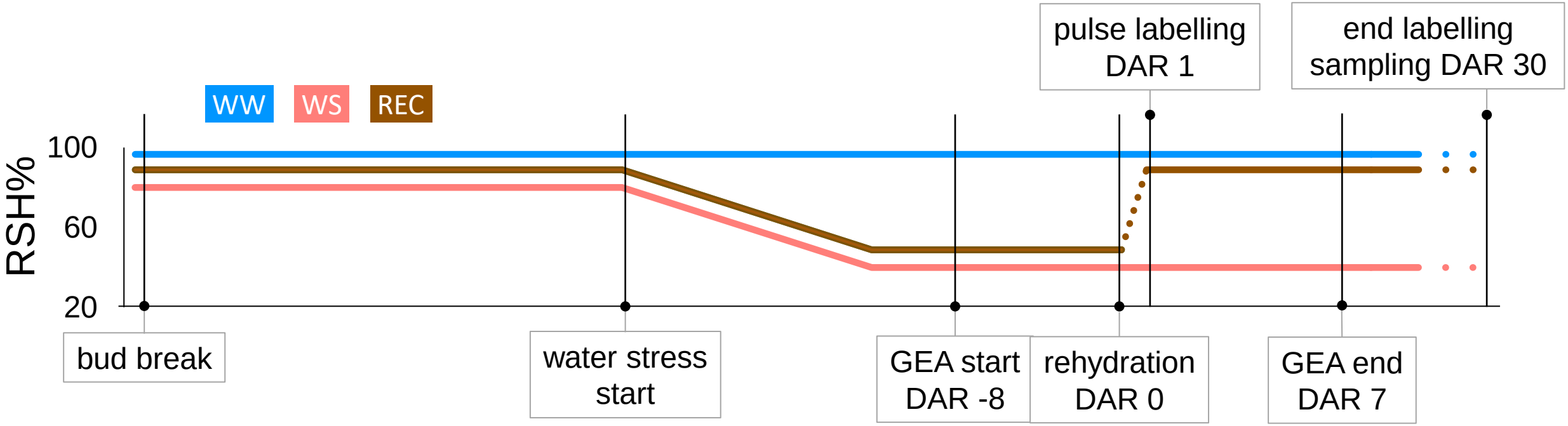
AIR RELATIVE HUMIDITY

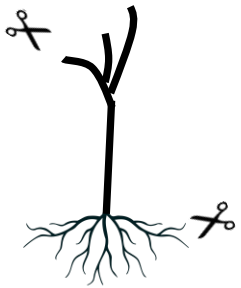
$CO_2$ CONCENTRATION

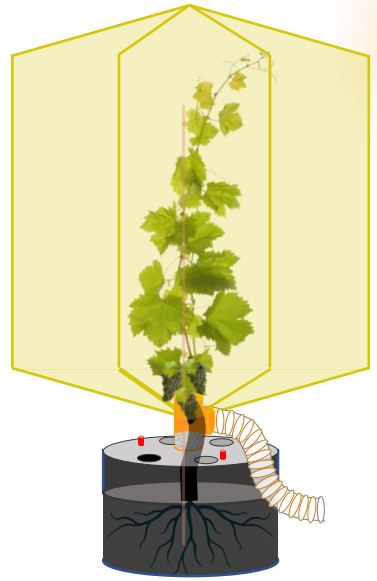

*$CO_2$ injection system*

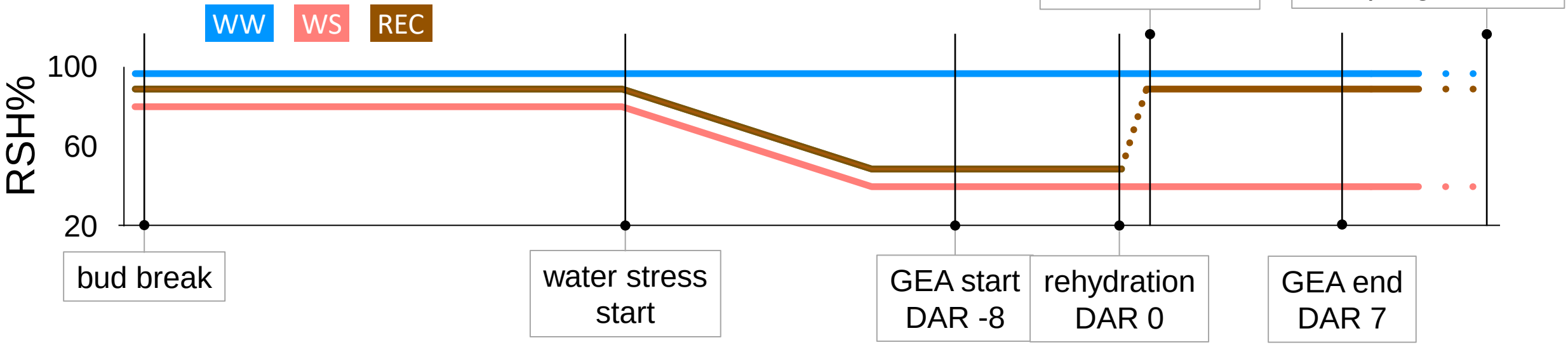


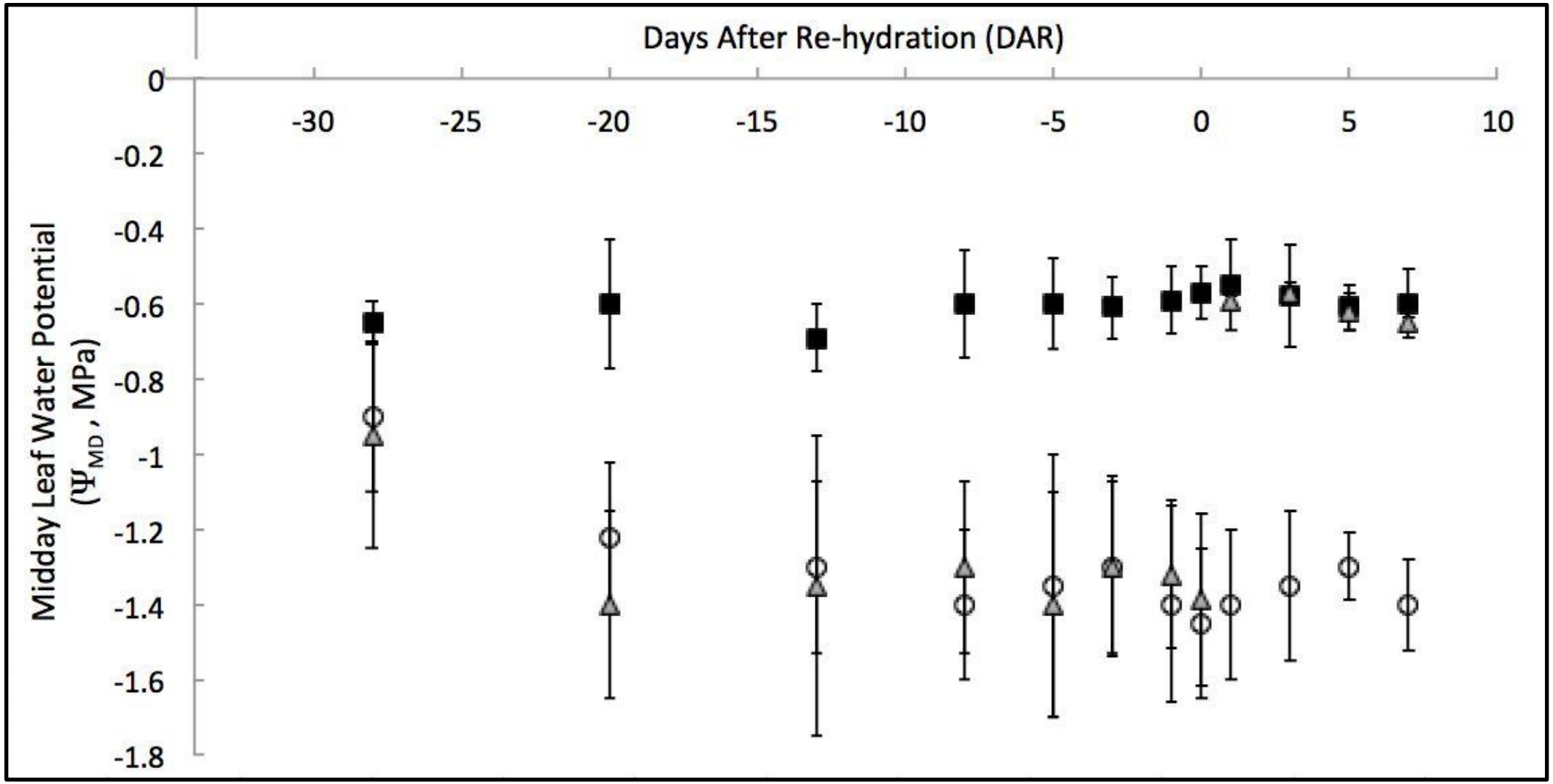

WW
WS
REC
RSH%
100
60
20
bud break
water stress start
GEA start DAR -8
pulse labelling DAR 1
rehydration DAR 0
GEA end DAR 7
end labelling sampling DAR 30

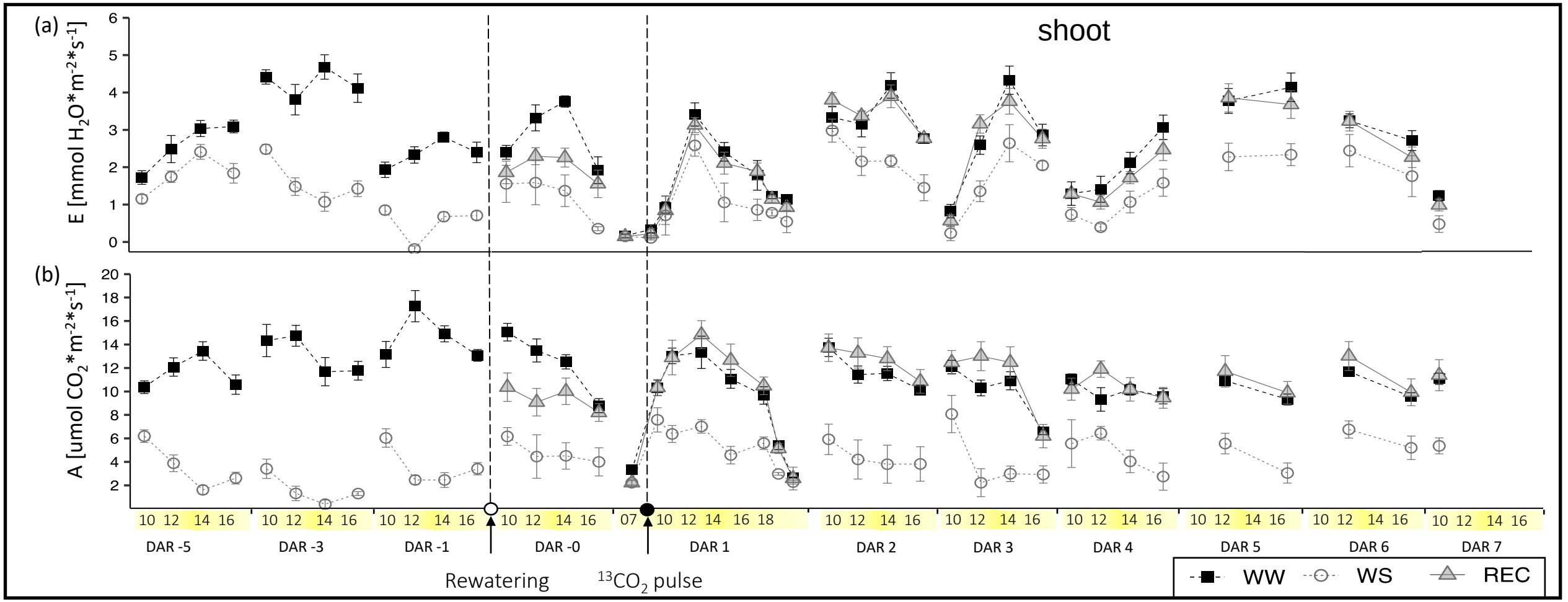


DAR 0
=
100% veraison

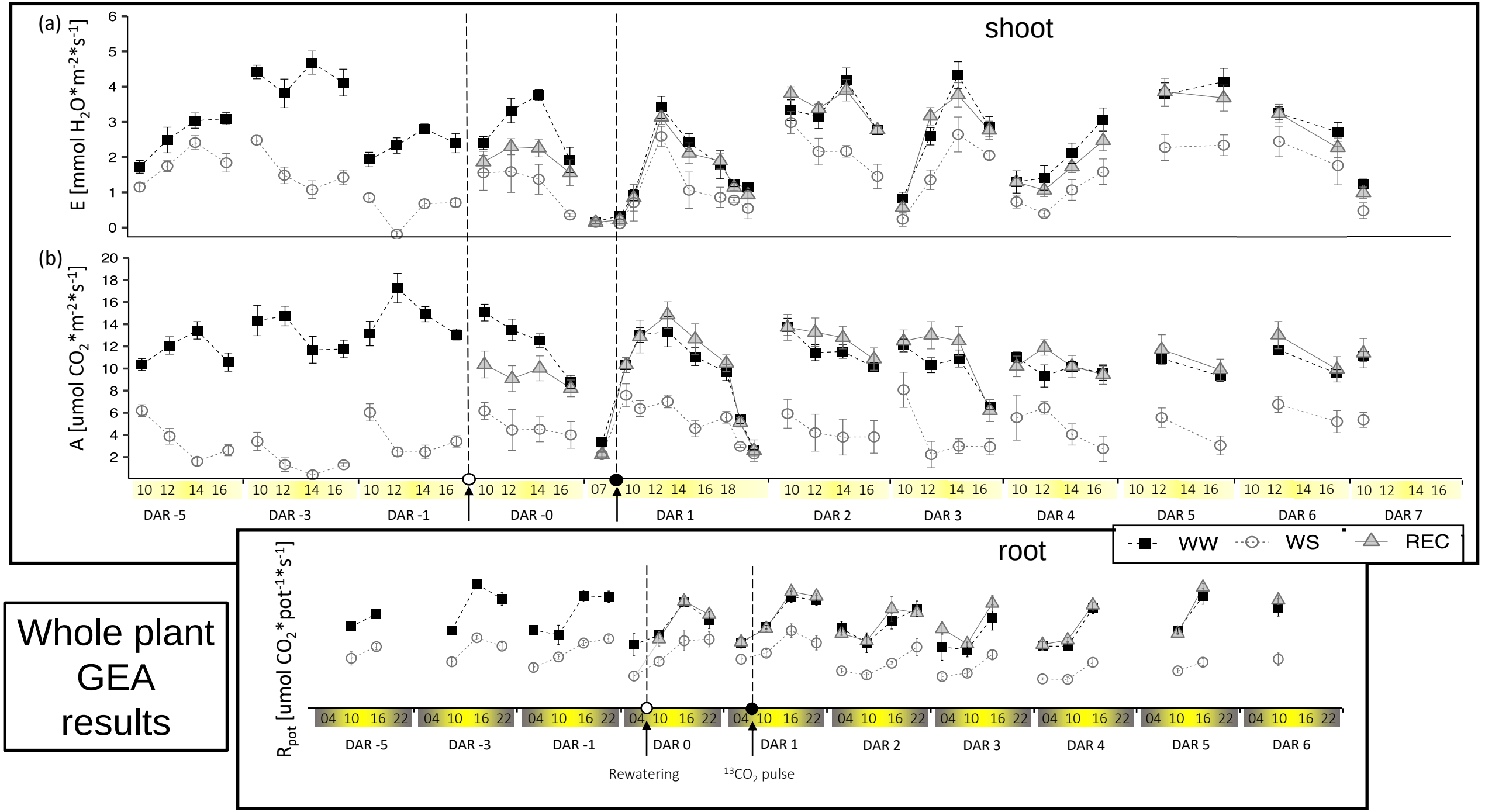





Days After Re-hydration (DAR)
0
-30
-25
-20
-15
-10
-5
0
5
10
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
Midday Leaf Water Potential
($\Psi_{MD}$, MPa)

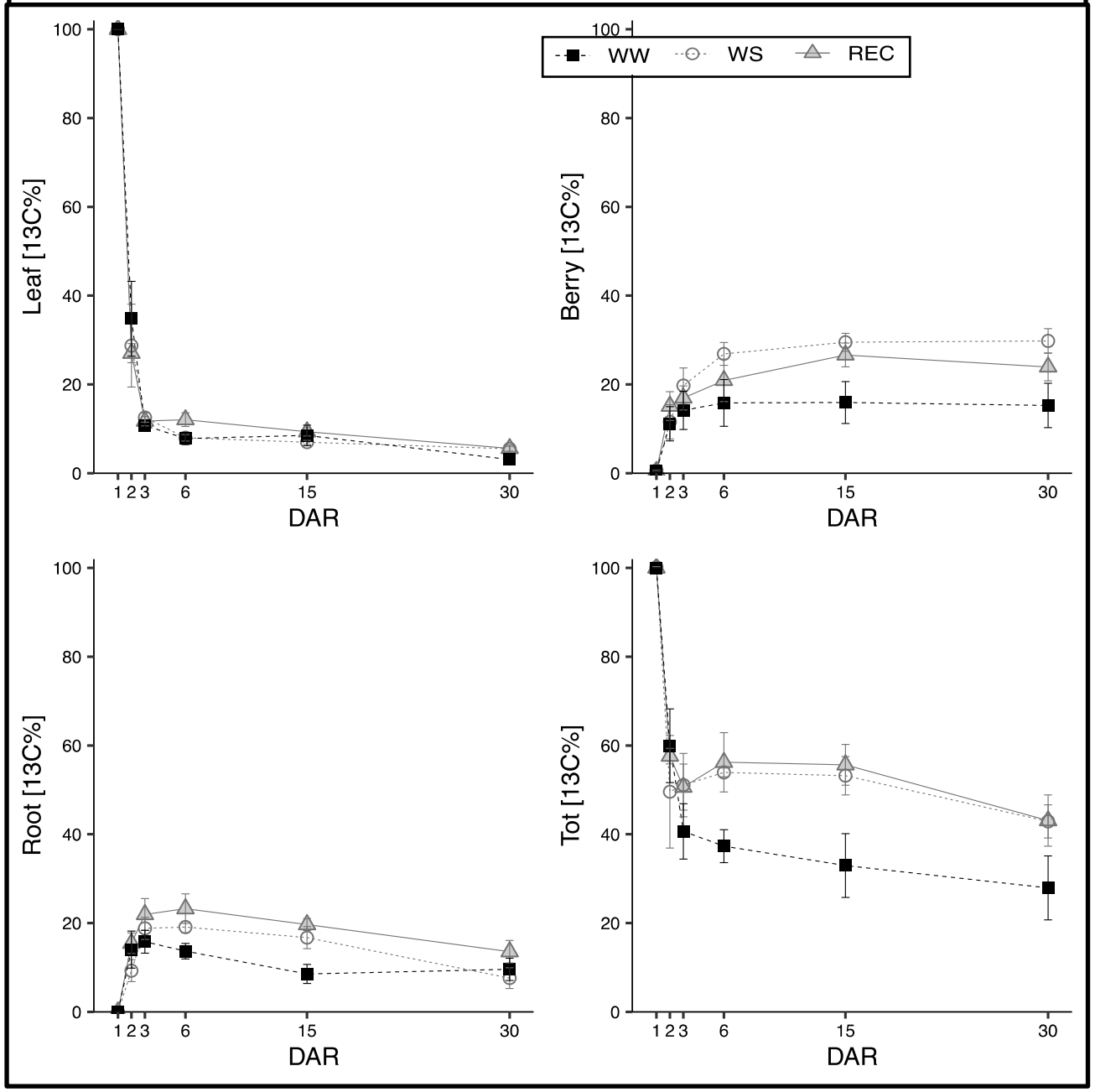



Whole plant GEA results

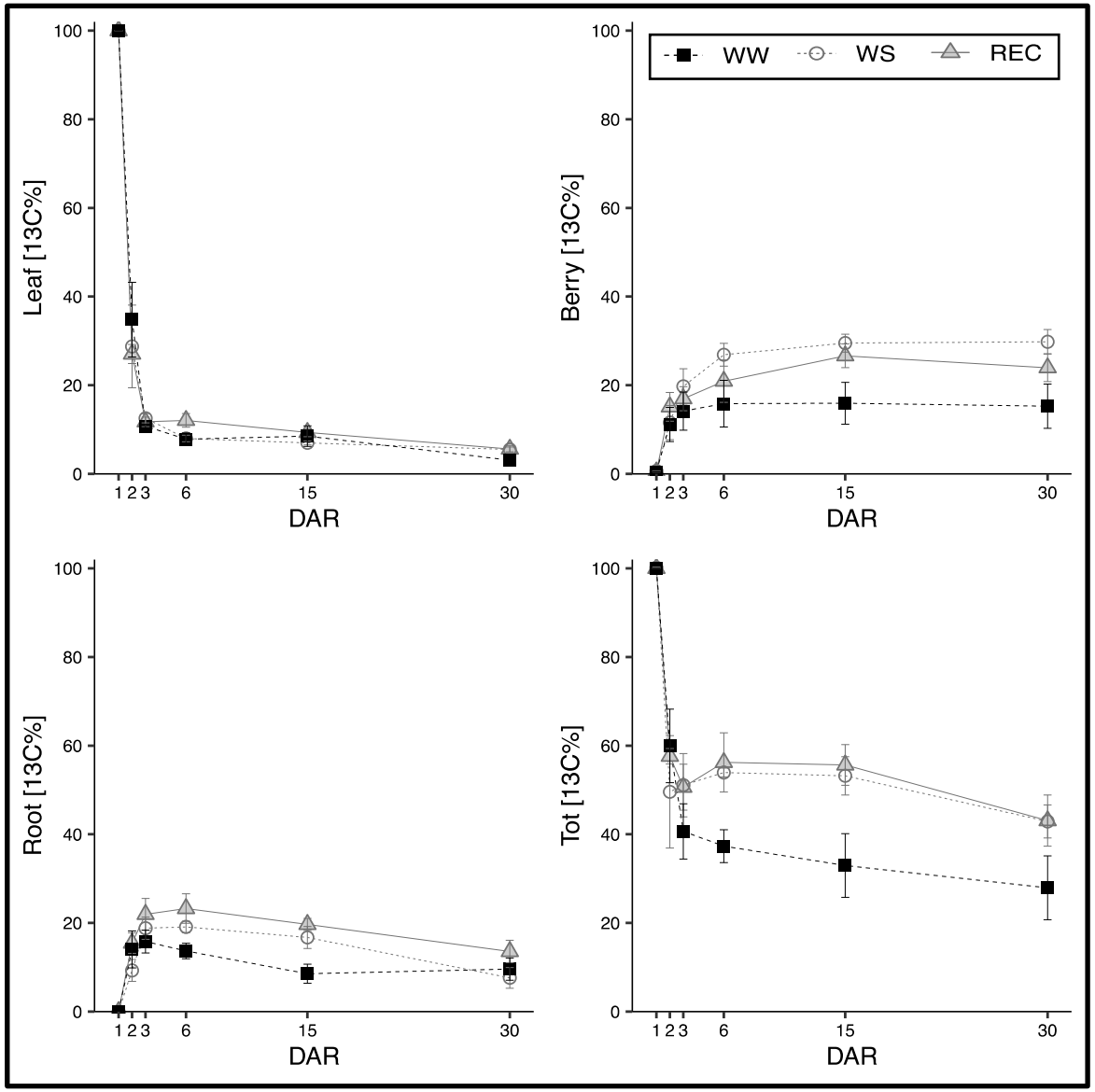


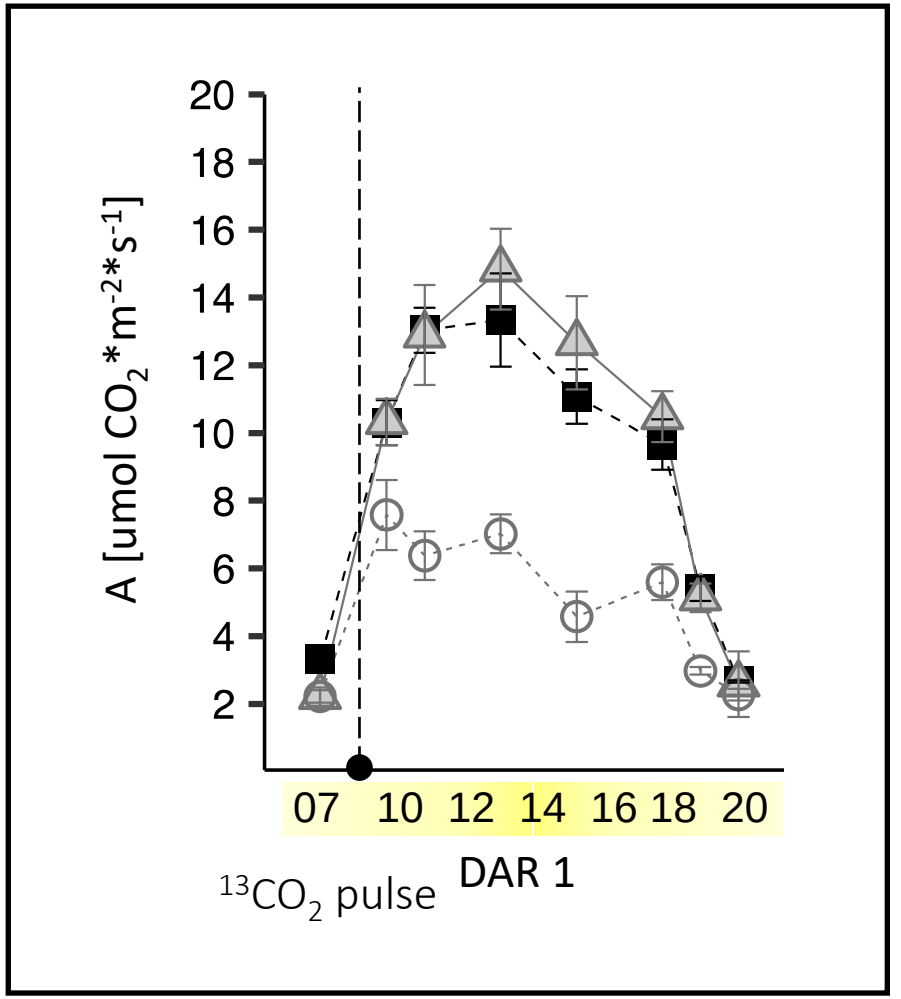

Whole plant GEA results

# Pulse labelling results: carbon partitioning



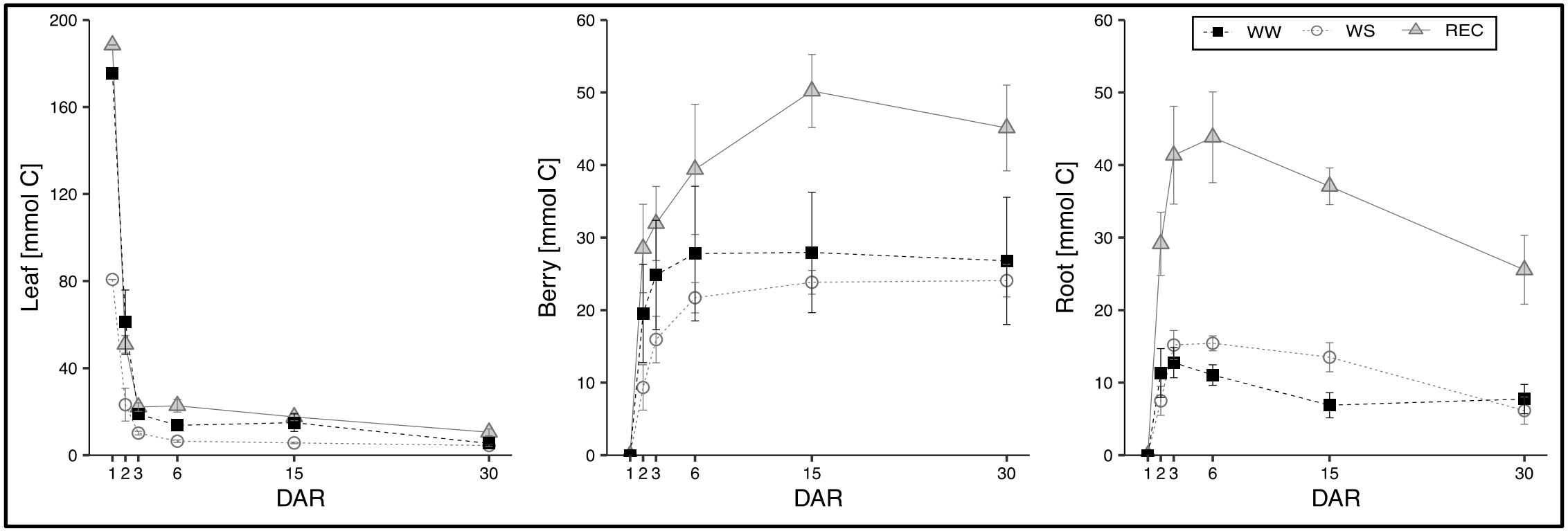
Carbon partitioning



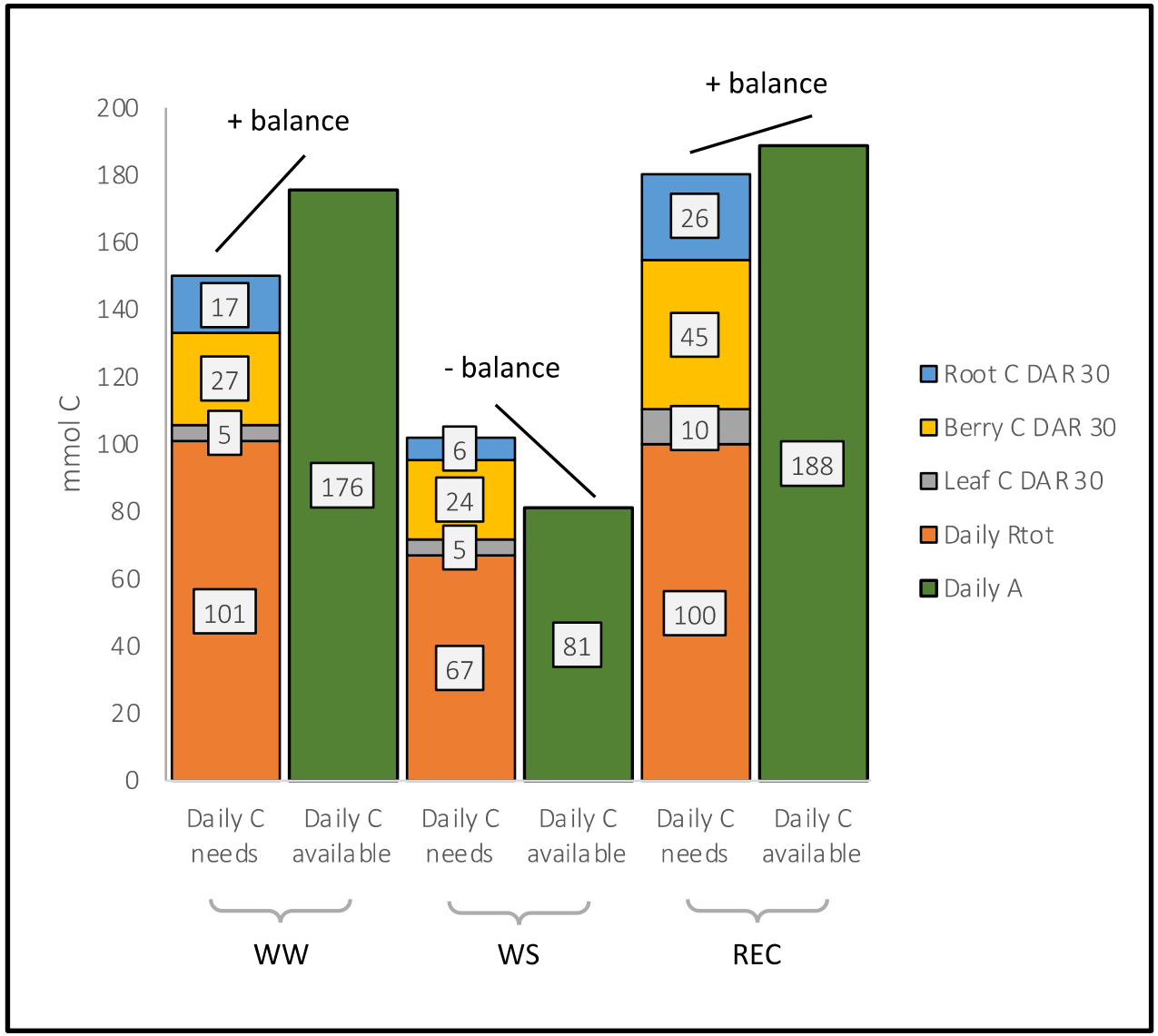



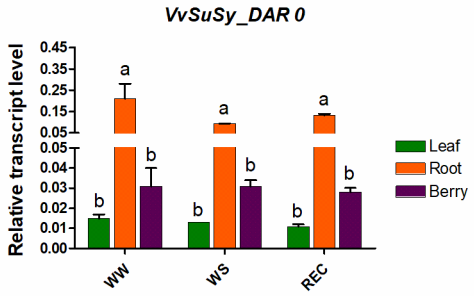

Integral $A_{net}$ DAR 1

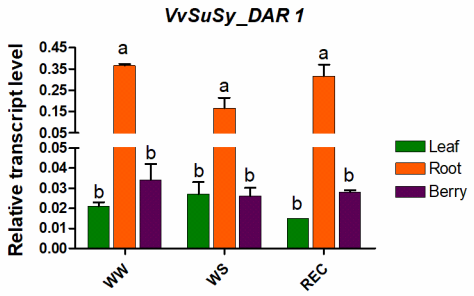
# Carbon accumulation

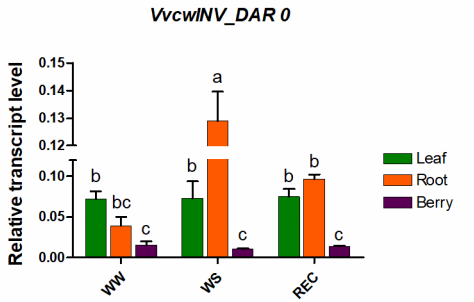


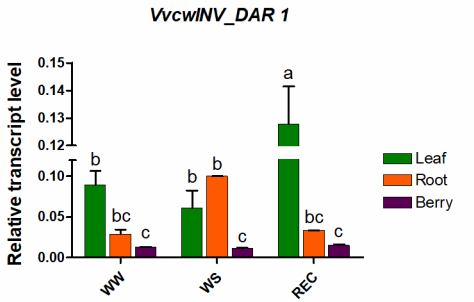
# Model of C allocation to different C pools

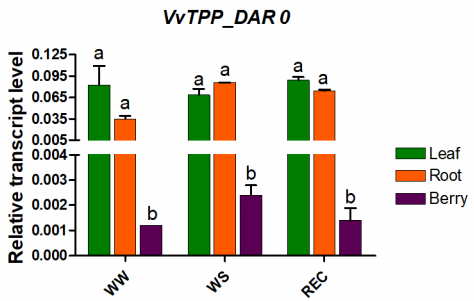


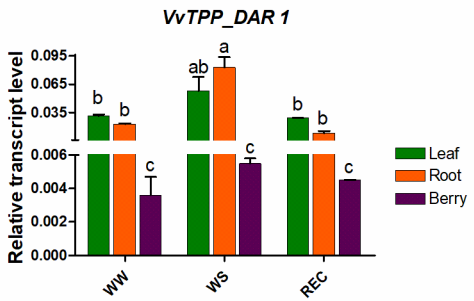

VvSuSy_DAR 0
Relative transcript level
Leaf
Root
Berry
WW
WS
REC


VvSuSy_DAR 1
Relative transcript level
Leaf
Root
Berry
WW
WS
REC


VvcwINV_DAR 0
Relative transcript level
Leaf
Root
Berry
WW
WS
REC


VvcwINV_DAR 1
Relative transcript level
Leaf
Root
Berry
WW
WS
REC


VvTPP_DAR 0
Relative transcript level
Leaf
Root
Berry
WW
WS
REC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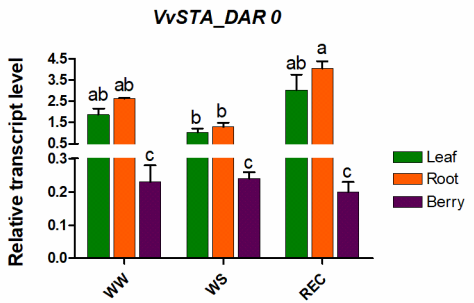
Relative transcript level
Leaf
Root
Berry
WW
WS
REC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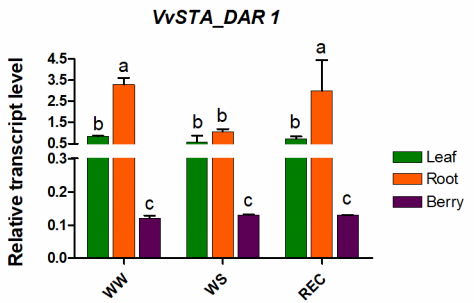
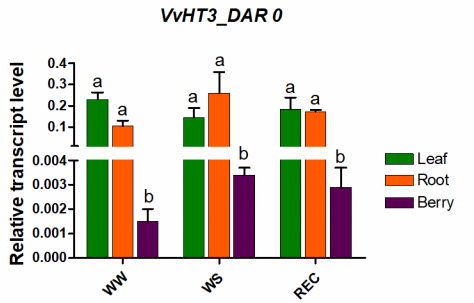
Relative transcript level
Leaf
Root
Berry
WW
WS
REC


VvSTA_DAR 1
Relative transcript level
Leaf
Root
Berry
WW
WS
REC


VvHT3_DAR 0
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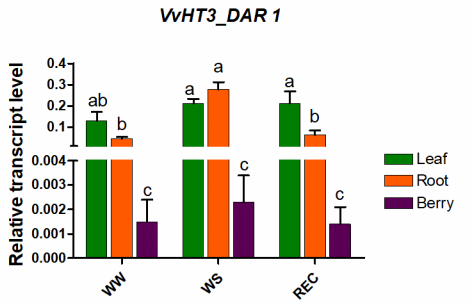
Leaf
Root
Berry
WW
WS
REC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WS
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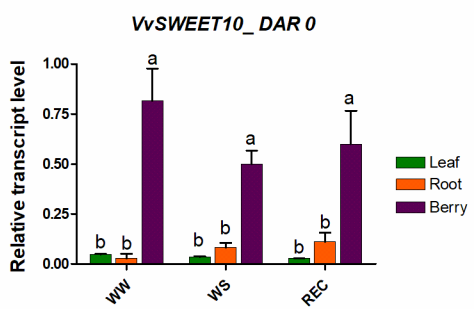
VvSWEET10_ DAR 0
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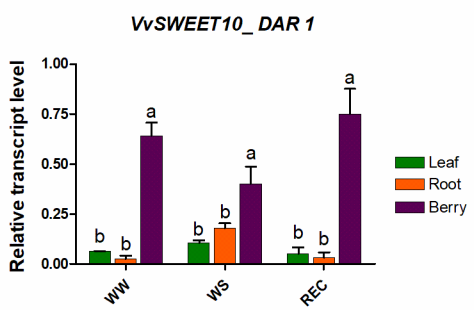
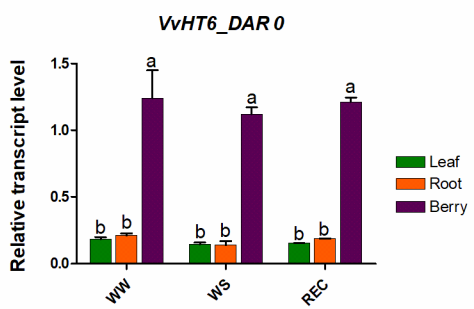
Leaf
Root
Berry
WW
WS
REC


VvSWEET10_ DAR 1
Relative transcript level
Leaf
Root
Berry
WW
WS
REC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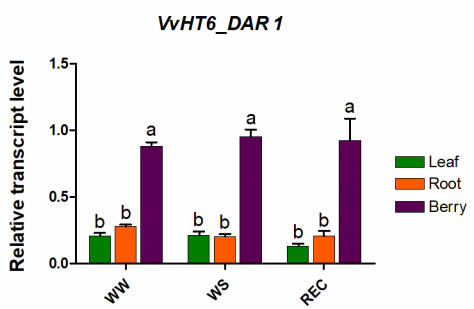
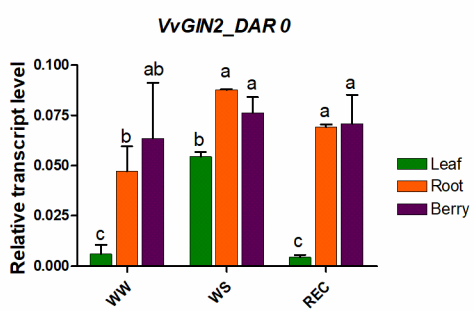
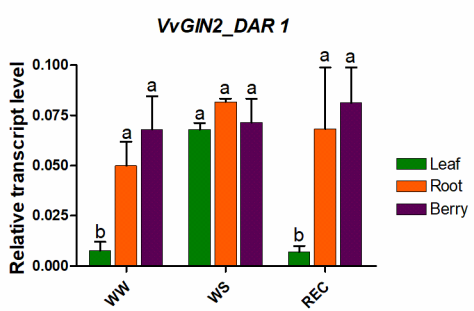
Relative transcript level
Leaf
Root
Berry
WW
WS
REC

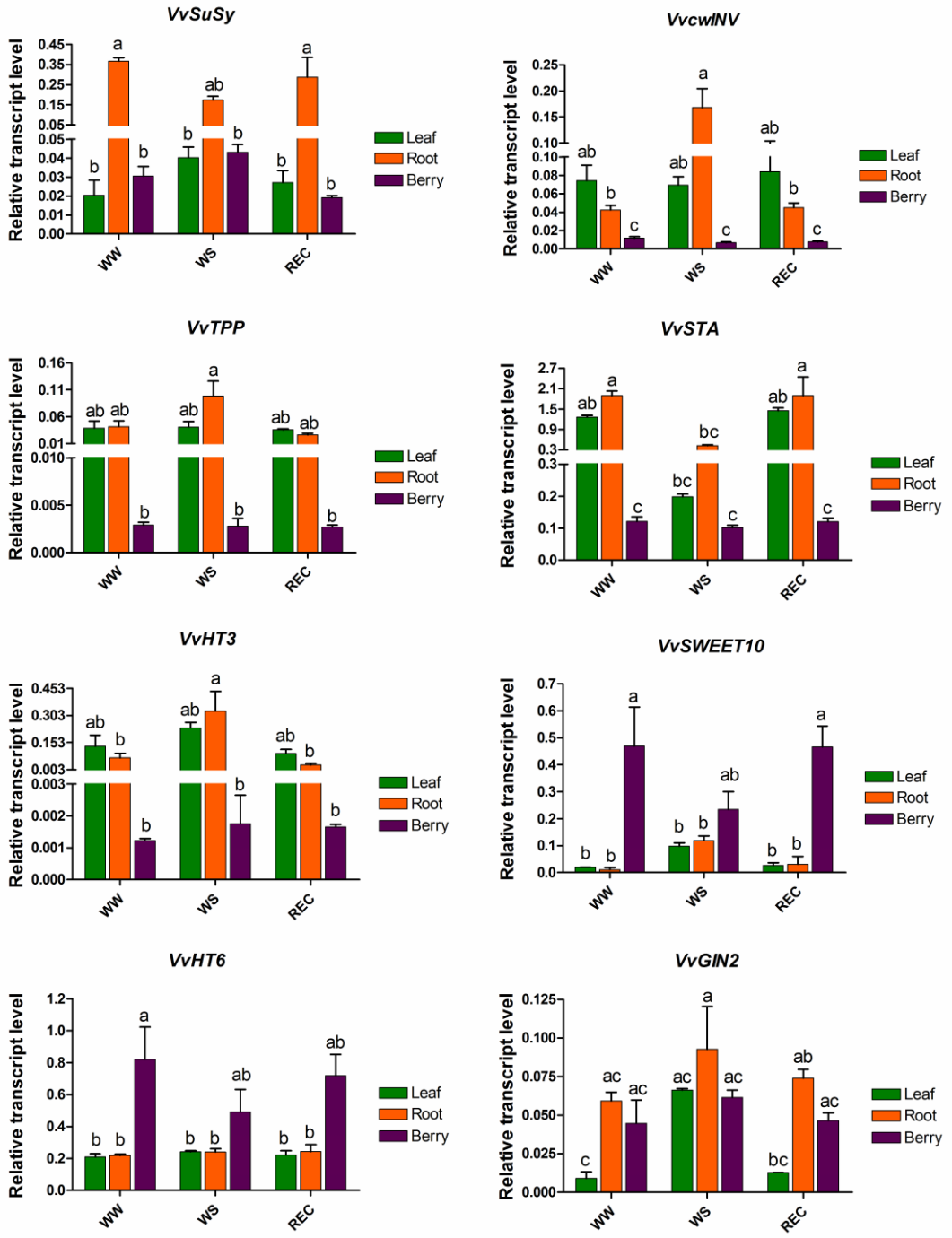

VvHT6_DAR 1
Relative transcript level
Leaf
Root
Berry
WW
WS
REC


VvGIN2_DAR 0
Relative transcript level
Leaf
Root
Berry
WW
WS
REC


VvGIN2_DAR 1
Relative transcript level
Leaf
Root
Berry
WW
WS
REC

Transcripts of key genes of sugar metabolism:
sucrose synthase (*VvSuSy*),
cell wall invertase (*VvcwINV*),
threalose 6-phosphate phosphatase (VvTPP),
starch synthase (*VvSTA*),
hexose transporter 3 (*VvHT3*),
Sugar Will Eventually be Exported Transporter 10 (*VvSWEET10*),
Hexose transporter 6 (*VvHT6*),
vacuolar invertase 2 (*VvGIN2*) genes

in leaf, root and berry tissues
sampled from WW, WS and REC plants
at DAR 4



# Attivazione durante lo stress idrico di meccanismi molecolari di segnale ABA - o calcio - dipendenti

Environmental and Experimental Botany 103 (2014) 138–147

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journal homepage: www.elsevier.com/locate/envexpbot

## Abiotic stress effects on grapevine (*Vitis vinifera* L.): Focus on abscisic acid-mediated consequences on secondary metabolism and berry quality

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*University of Torino, Department of Agricultural, Forest and Food Sciences, via Leonardo da Vinci, 44, 10095 Grugliasco, Italy*

# Conclusioni

- **Le colture da frutto (nello specifico, la vite) non abbisognano di rifornimenti idrici (irrigui) costanti durante la stagione di crescita e di fruttificazione.**

- **Al contrario, un periodo di deficit idrico controllato è auspicabile se accoppiato ad eventi di reidratazione.**

- **Lo stress idrico deve rimanere al di sopra di livelli minimi di idratazione dei tessuti, che sarebbero difficilmente recuperabili.**

- **In questo caso la reidratazione post-stress idrico risulta strategicamente vincente.**

- **La pianta nelle fasi post-reidratazione recupera il tasso fotosintetico fogliare e stimola l'attività dei sink di accumulo degli zuccheri.**

- **Questo causa un aumento della respirazione radicale, della biomassa microbica della rizosfera del suolo, e dell'accumulo di composti di riserva nei frutti (obiettivo finale del processo di coltivazione) e delle vie biosintetiche per colore e aroma.**


Dipartimento di eccellenza
Piattaforma PhenoPlant
Il più avanzato sistema in Italia di fenotipizzazione automatizzato progettato per lo studio di piante e colture.
La piattaforma sarà composta da strutture per la coltivazione e la movimentazione di piante in vaso o alveolo: garantirà in continuo l'irrigazione, la fertirrigazione, il controllo dell'illuminazione, della temperatura e dell'umidità.
La dotazione strumentale permetterà la rilevazione automatizzata di caratteri morfologici, strutturali e funzionali, oltre che la misurazione automatizzata dei parametri di crescita e fitness delle piante ed il rilievo dei parametri ambientali.
La piattaforma PhenoPlant rispunde alla necessità di misurare simultaneamente e con precisione molti caratteri strutturali e funzionali di un numero sempre più elevato di specie vegetali (il cosiddetto plant phenotyping) al fine di studiare
le correlazioni tra espressione fenotipica, parametri ambientali e corredo genetico.
La comprensione dei processi che regolano le strategie di adattamento all'ambiente ed alle tecniche colturali è essenziale per il progresso delle scienze di base e per le molteplici implicazioni agronomiche e tecnologiche.
UNIVERSITÀ DEGLI STUDI DI TORINO
DISAFA


Piattaforma PhenoPlant
Responsabile unico del Procedimento
e Responsabile dei lavori: Ingegnere Sandro Petruzzi
Direzione Edilizia e Sostenibilità, Via Po 31 Torino
Progettazione
Progetto Architettonico: Ing. Giorgio Braccardo
Strutturale Via Cresa Lunga Inferiore, 5
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Coordinatore della sicurezza
per la progettazione: Arch. Maria Rita Lagostena
Via Ilva 2/15 – Genova (GE)
Ufficio di direzione lavori
Direttore dei lavori: Ing. Giampaolo Armentano
Generale e strutture Direzione Edilizia e Sostenibilità,
Via Po 31 Torino (TO)
Coordinatore della sicurezza
per la esecuzione lavori: Arch. Maria Rita Lagostena
Via Ilva 2/15 – Genova (GE)
Durata stimata dei lavori: 120 giorni naturali consecutivi
IMPORTO DEL CONTRATTO: euro 239.000,00
IMPORTO LAVORI: euro 223.000,00
ONERI PER LA SICUREZZA: euro 16.000,00
Impresa esecutrice: METALMAT DI MATTOSCIO ANDREA
Via Provinciale, 48, 17055 Tovrano (SV)
Impresa ausiliaria: IDEAL RESTAURO CONSERVATIVO SRL
Piazza Vittorio Veneto n°14 - 10123 Torino
Qualificazione per i lavori della categoria: OG1 - classifica I
Direttore tecnico del cantiere: Mattoscio Giancarlo
Subappaltatore: IDEAL RESTAURO CONSERVATIVO SRL
Piazza Vittorio Veneto n°14 - 10123 Torino


RIPE
PHENOSPEX


TRANSMISSION

Visualize **plant growth** with a wide variety of **morphological parameters** such as:

- **Plant Height Max**
- **Plant Height Average**
- **Canopy Light Penetration Depth**
- **3D Leaf Area**
- **Projected Leaf Area**
- **Digital Biomass**
- **Convex Hull Area**
- **Convex Hull Area Coverage**
- **Convex Hull Circumference**
- **Convex Hull Maximum Width**
- **Convex Hull Aspect Ratio**
- **Voxel Volume Total**
- **Surface Angle Average**

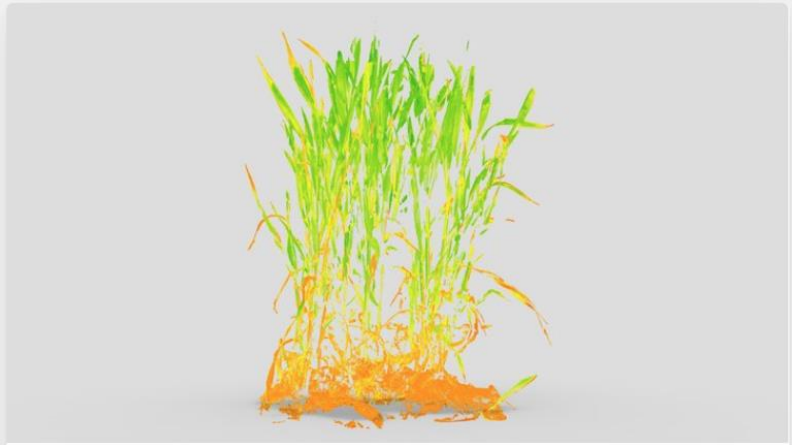
PlantEye measures the RGB & NIR **spectral reflectance** of the plant. Each wavelength can be statistically analyzed individually to calculate and quantify:

- **HUE average (Color)**
- **Lightness average**
- **Saturation average**

RGB & NIR Wavelengths are combined into **spectral indices**. At the moment we can calculate the most important indices like:

- **Normalized Digital Vegetation Index (NDVI)**
- **Normalized Pigments Chlorophyll ratio index (NPCI)**
- **Plant Senescence Reflectance Index (PSRI)**
- **Green Leaf Index (GLI)**

Wheat Field | 3D & RGB | Field Ph... 598 0 4



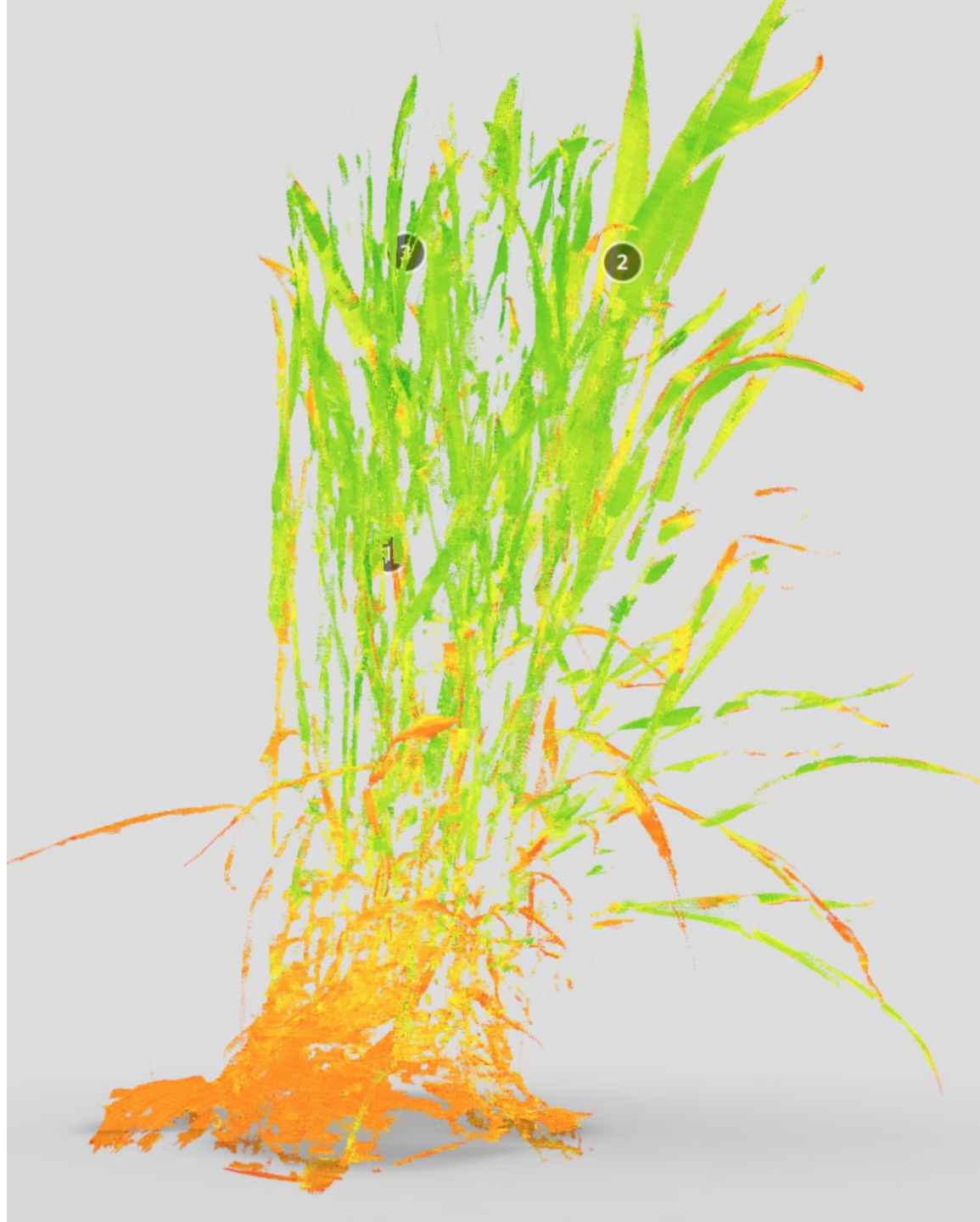
Wheat field | Health map | NDVI ... 2.9k 0 5

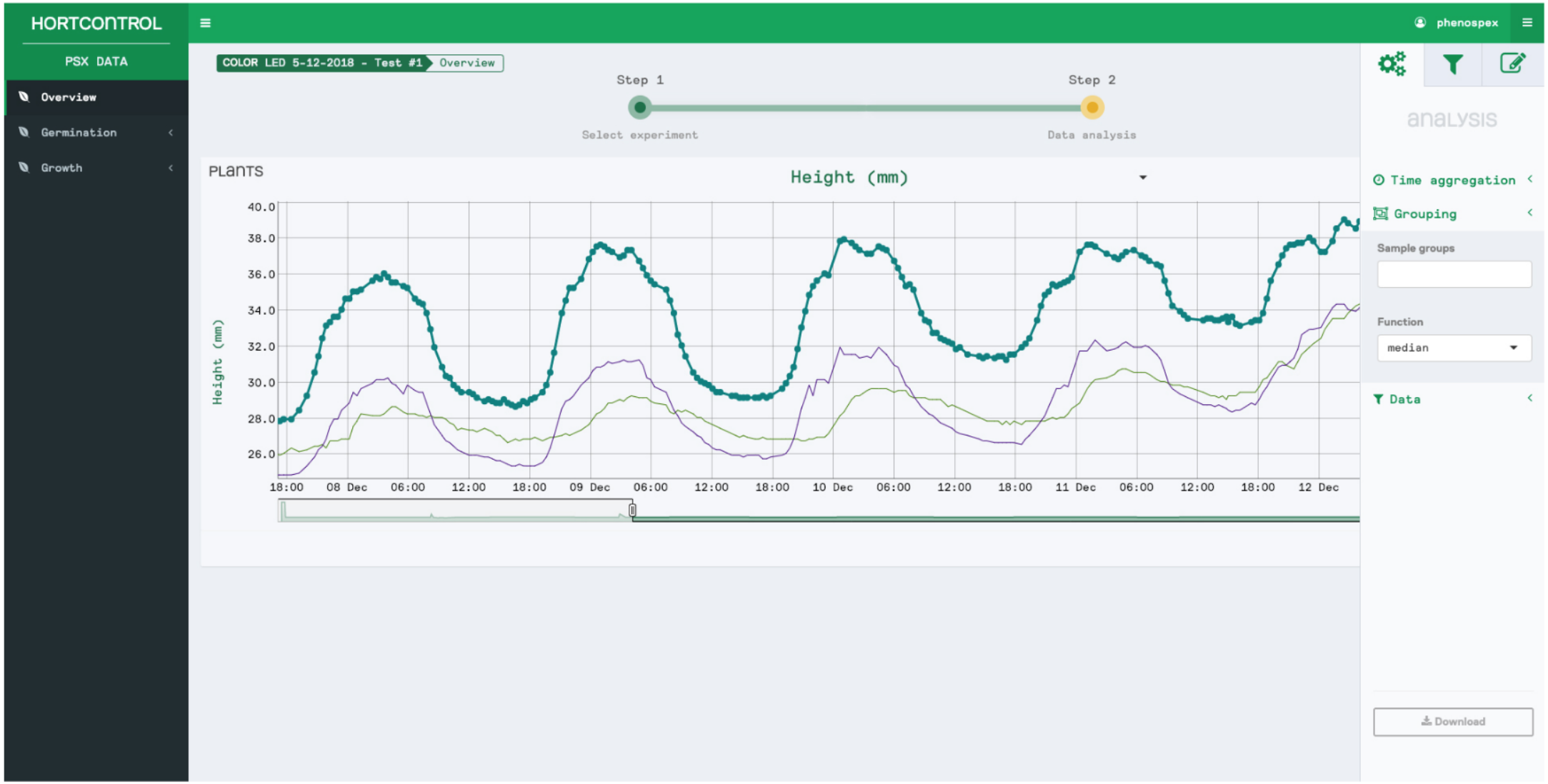
Tomato | Big seedlings | Growth s... 486 0 3

Soy Bean | Experiment with a che... 787 0 3

Basilicum RGB - PlantEye F500 367 0 2

Maize | Stage V11 | NDVI plant h... 25.4k 5 5


1
2




*Growth dynamics of tomato plants (height in mm) visualized over time. The high scan intervals reveal leaf movements over the the day showing the benefit of high quality and throughput in digital plant phenotyping.*

# Sviluppi futuri

- Accoppiamento delle piattafome di misura dello **scambio gassoso** (fotosintesi, respirazione) e del **labeling del carbonio** con la fenotipizzazione ottica (**imaging multispettrale**).

- In situazioni pilota si puo' ipotizzare la presenza delle **3 misure combinate** al fine di ottenere **livelli soglia di stress** al fine di ottimizzazione la qualità delle produzioni delle piante **con report dell'imaging multispettrale**.

- Ricerca di questi livelli in campo con mezzi a **scala aziendale** (misura a terra o su drone).

- Ricerca di questi livelli con mezzi a **scala territoriale** (satellite).

- Importanza del portinnesto

CSIRO PUBLISHING

*Functional Plant Biology*, 2014, **41**, 1119–1128
http://dx.doi.org/10.1071/FP13263

## Soil water-holding capacity mediates hydraulic and hormonal signals of near-isohydric and near-anisohydric *Vitis* cultivars in potted grapevines

*Sara Tramontini*[A,B,D,E], *Johanna Döring*[C,D], *Marco Vitali*[B], *Alessandra Ferrandino*[B], *Manfred Stoll*[C] *and Claudio Lovisolo*[B]

Physiologia Plantarum

An International Journal for Plant Biology

Physiologia Plantarum 159: 468–482. 2017



## Factors influencing stomatal conductance in response to water availability in grapevine: a meta-analysis

Anouk Lavoie-Lamoureux, Dario Sacco, Paul-André Risse and Claudio Lovisolo*

- Importanza del portinnesto

Plant Soil (2013) 368:215–230
DOI 10.1007/s11104-012-1507-x

REGULAR ARTICLE

# Impact of soil texture and water availability on the hydraulic control of plant and grape-berry development

Sara Tramontini · Cornelis van Leeuwen · Jean-Christophe Domec · Agnès Destrac-Irvine · Cyril Basteau · Marco Vitali · Olaf Mosbach-Schulz · Claudio Lovisolo

ELSEVIER

Contents lists available at SciVerse ScienceDirect

Environmental and Experimental Botany

journal homepage: www.elsevier.com/locate/envexpbot


# Rootstock control of scion response to water stress in grapevine


Sara Tramontini[a,b,*], Marco Vitali[b], Luna Centioni[b], Andrea Schubert[b], Claudio Lovisolo[b,c]

- Importanza del portinnesto

# The Grapevine Root-Specific Aquaporin *VvPIP2;4N* Controls Root Hydraulic Conductance and Leaf Gas Exchange under Well-Watered Conditions But Not under Water Stress[1[W]]

Irene Perrone[2,3], Giorgio Gambino[2], Walter Chitarra, Marco Vitali, Chiara Pagliarani, Nadia Riccomagno, Raffaella Balestrini, Ralf Kaldenhoff, Norbert Uehlein, Ivana Gribaudo, Andrea Schubert*, and Claudio Lovisolo

CSIRO PUBLISHING

www.publish.csiro.au/journals/fpb

Review

*Functional Plant Biology*, 2010, **37**, 98–116

# Drought-induced changes in development and function of grapevine (*Vitis* spp.) organs and in their hydraulic and non-hydraulic interactions at the whole-plant level: a physiological and molecular update

*Claudio Lovisolo[A,C], Irene Perrone[A], Andrea Carra[A], Alessandra Ferrandino[A], Jaume Flexas[B], Hipolito Medrano[B] and Andrea Schubert[A]*

- Importanza del portinnesto

Research

New Phytologist

# An abscisic acid-related reduced transpiration promotes gradual embolism repair when grapevines are rehydrated after drought

Claudio Lovisolo[1]*, Irene Perrone[1]*, Wolfram Hartung[2] and Andrea Schubert[1]

ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Environmental and Experimental Botany 63 (2008) 178–182

Environmental and Experimental Botany

www.elsevier.com/locate/envexpbot

# Mercurial inhibition of root hydraulic conductance in *Vitis* spp. rootstocks under water stress

Claudio Lovisolo[a,*], Sara Tramontini[a], Jaume Flexas[c], Andrea Schubert[a,b]

- Fondazione **CRT**: Carbostress – Vitimount

- **MUR**:

  dottorati di ricerca

  DISAFA: Dipartimento di Eccellenza – *Carlo Grignani, Amedeo Reyneri (UNITO)*

- **PNRR** - *Luisella Celi (UNITO)*

Partenariato esteso GRINS - Growing Resilient, INclusive and Sustainable -Low carbon policies and socio-economic sustainability - *Paola Valbonesi (UNIPD), Francesco Quatraro, Valeria Di Cosmo (UNITO)*

ecosistema NODES – Nord Ovest Digitale e Sostenibile – VINO VIneyard management for viNeprOduction – *Hermes Giberti (UNIPV), Paolo Gay, Alberto Acquadro, Alessandra Ferrandino (UNITO)*