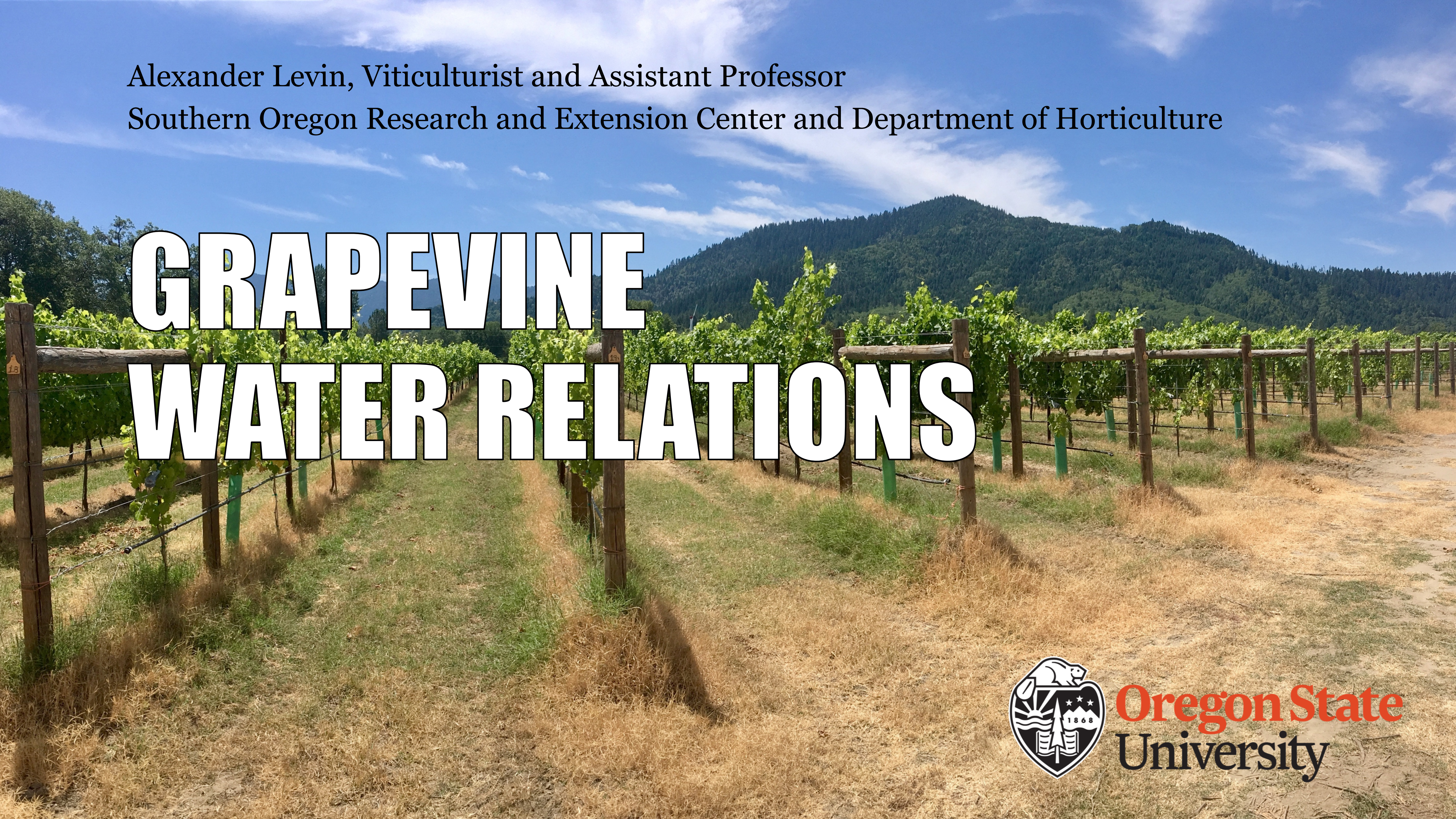
Alexander Levin, Viticulturist and Assistant Professor
Southern Oregon Research and Extension Center and Department of Horticulture

GRAPEVINE WATER RELATIONS



Oregon State University

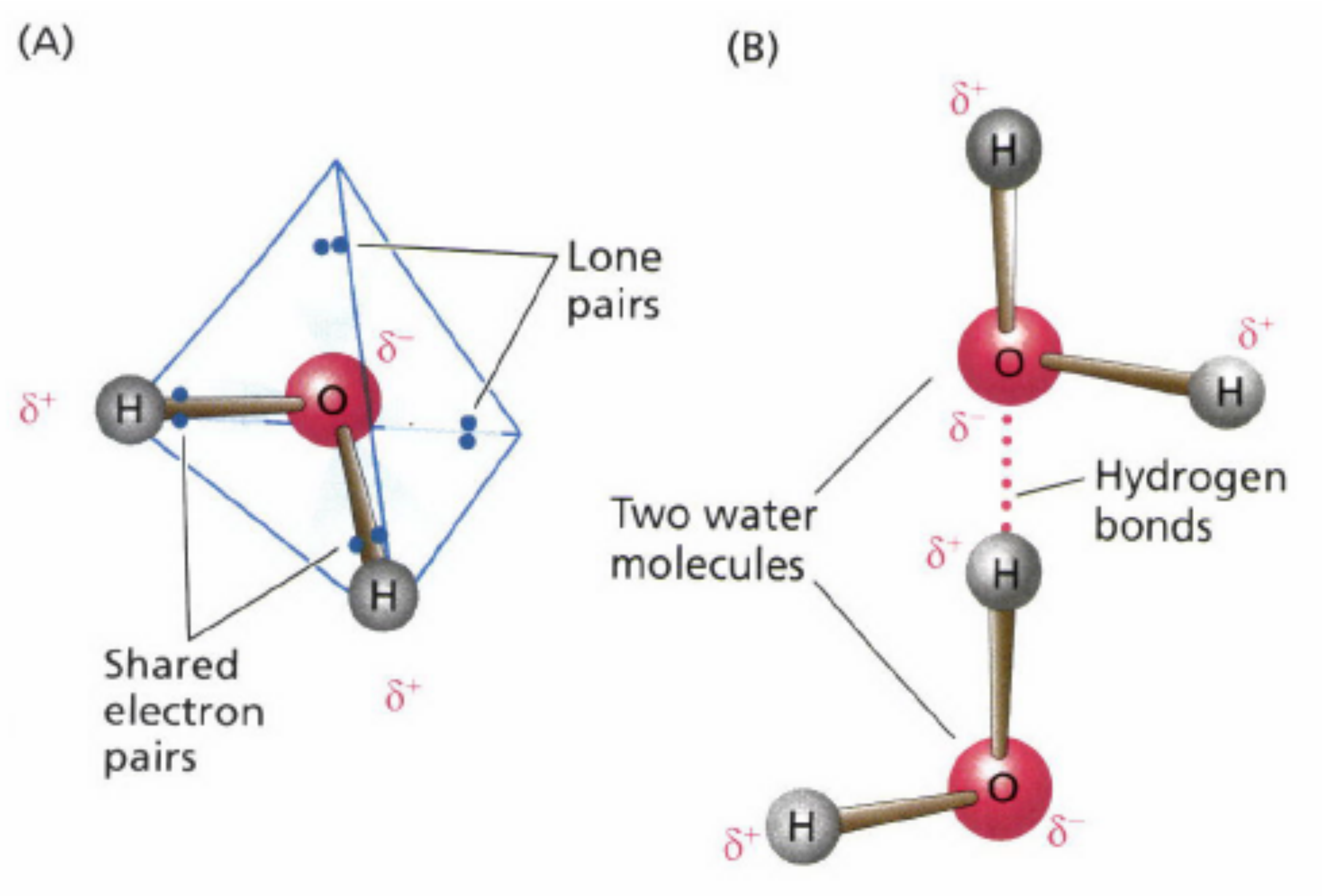
Physiology vs. culture

Plant physiologists are primarily interested in learning how [vines] grow, while [viticulturists] are interested primarily in how to grow [vines] efficiently. The two objectives are more closely related than generally supposed because in order to grow [vines] efficiently one must understand the basic physiological processes which control growth and how they are affected by environmental factors and cultural processes…The greatest overall progress will occur when physiologists learn more about how [vines] grow while [viticulturists] learn more about the physiology of [vines]…

Physiology of Woody Plants
(Kramer and Kozlowski, 1979)

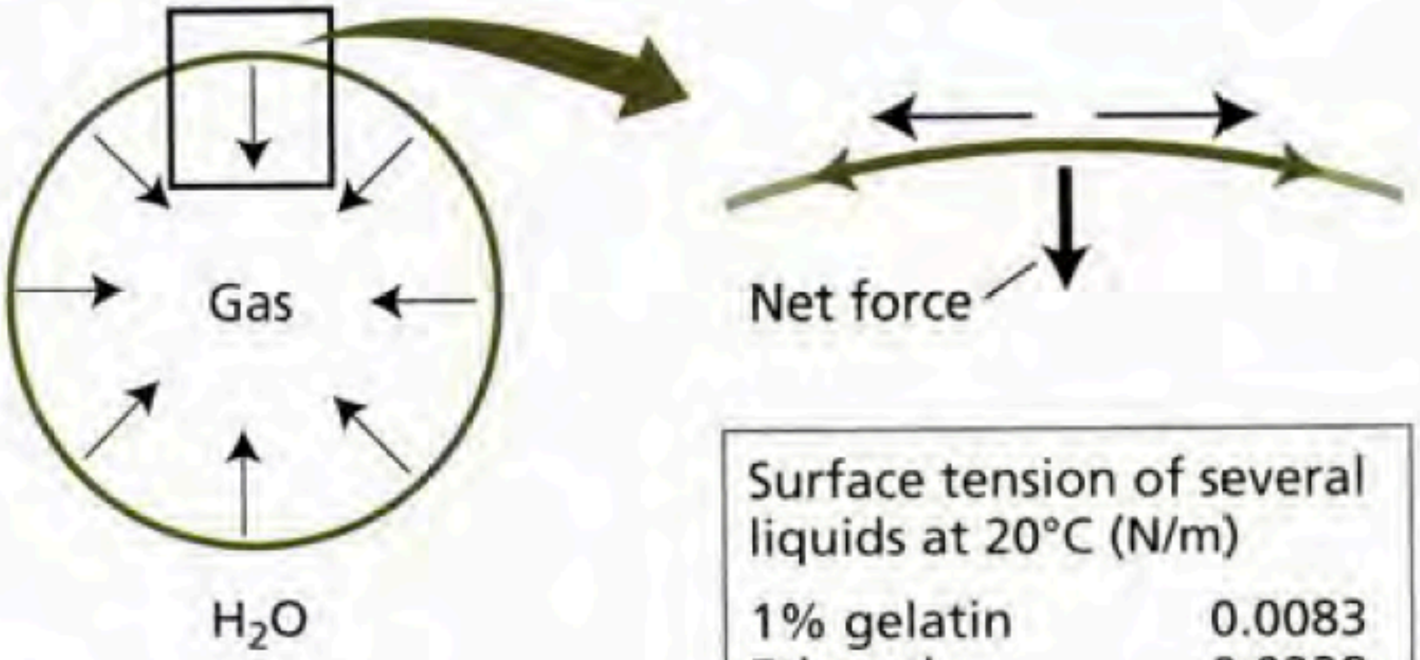
Structure and properties of
WATER

Size, shape, and polarity



Taiz and Zeiger (2010)

High surface tension

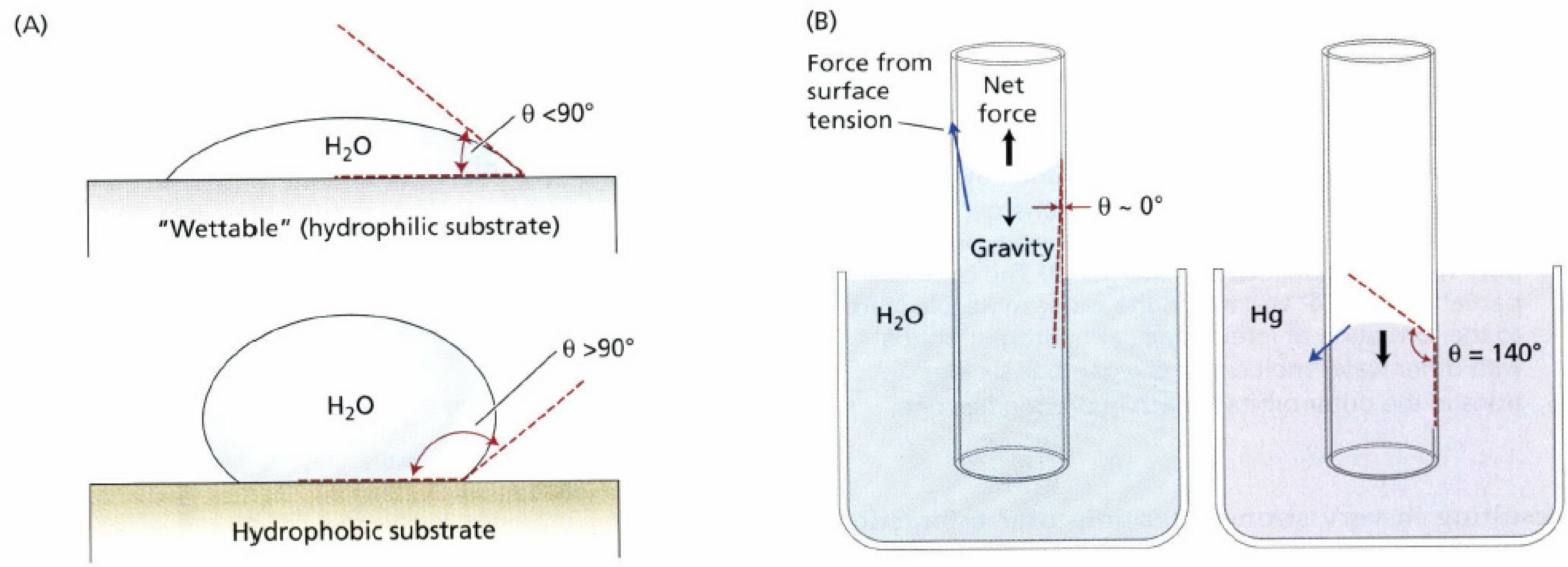


Surface tension of several liquids at 20°C (N/m)

1% gelatin	0.0083
Ethanol	0.0228
Phenol	0.0409
Water	0.0728

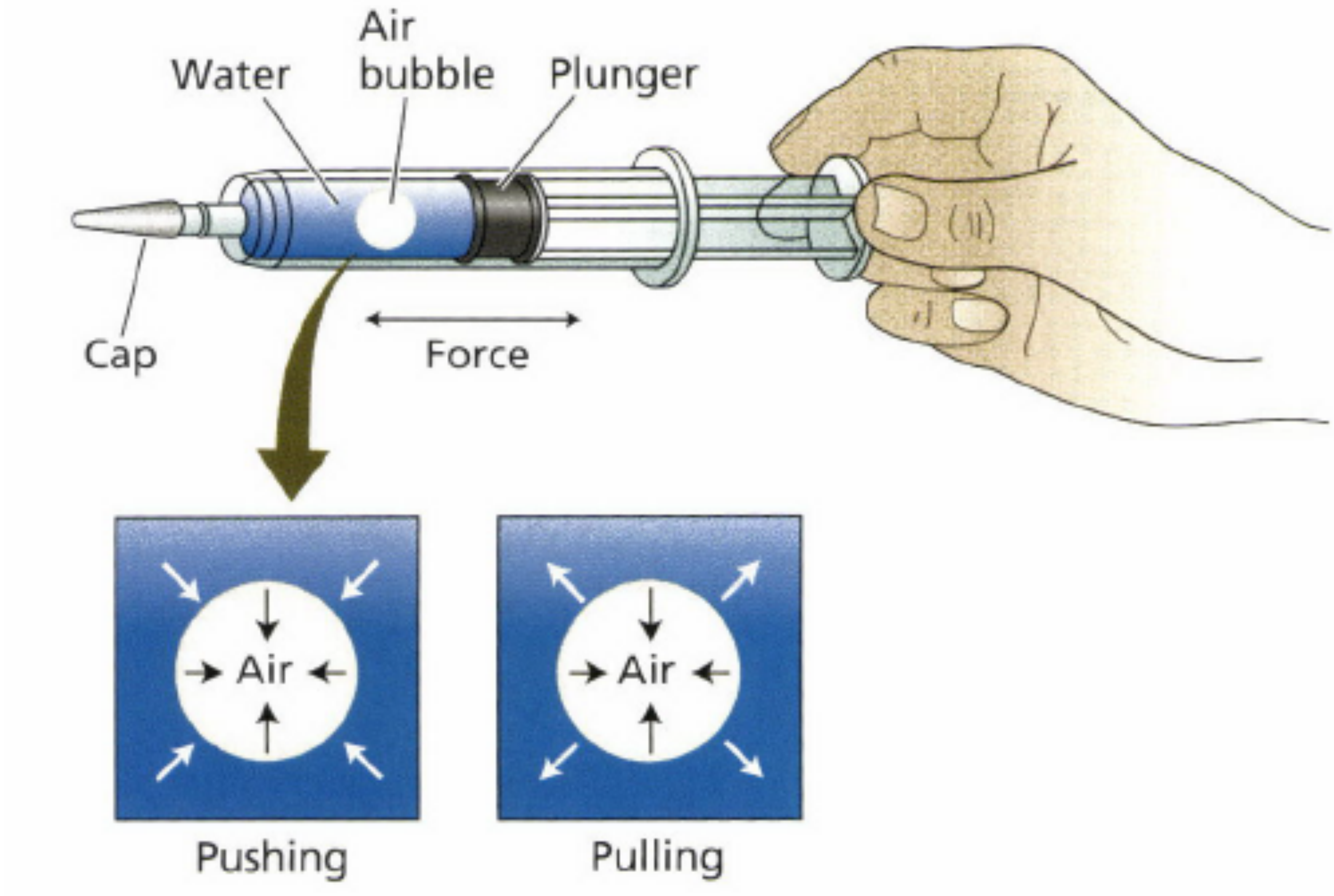
Taiz and Zeiger (2010)

Cohesion, adhesion, and capillarity



Taiz and Zeiger (2010)

High tensile strength

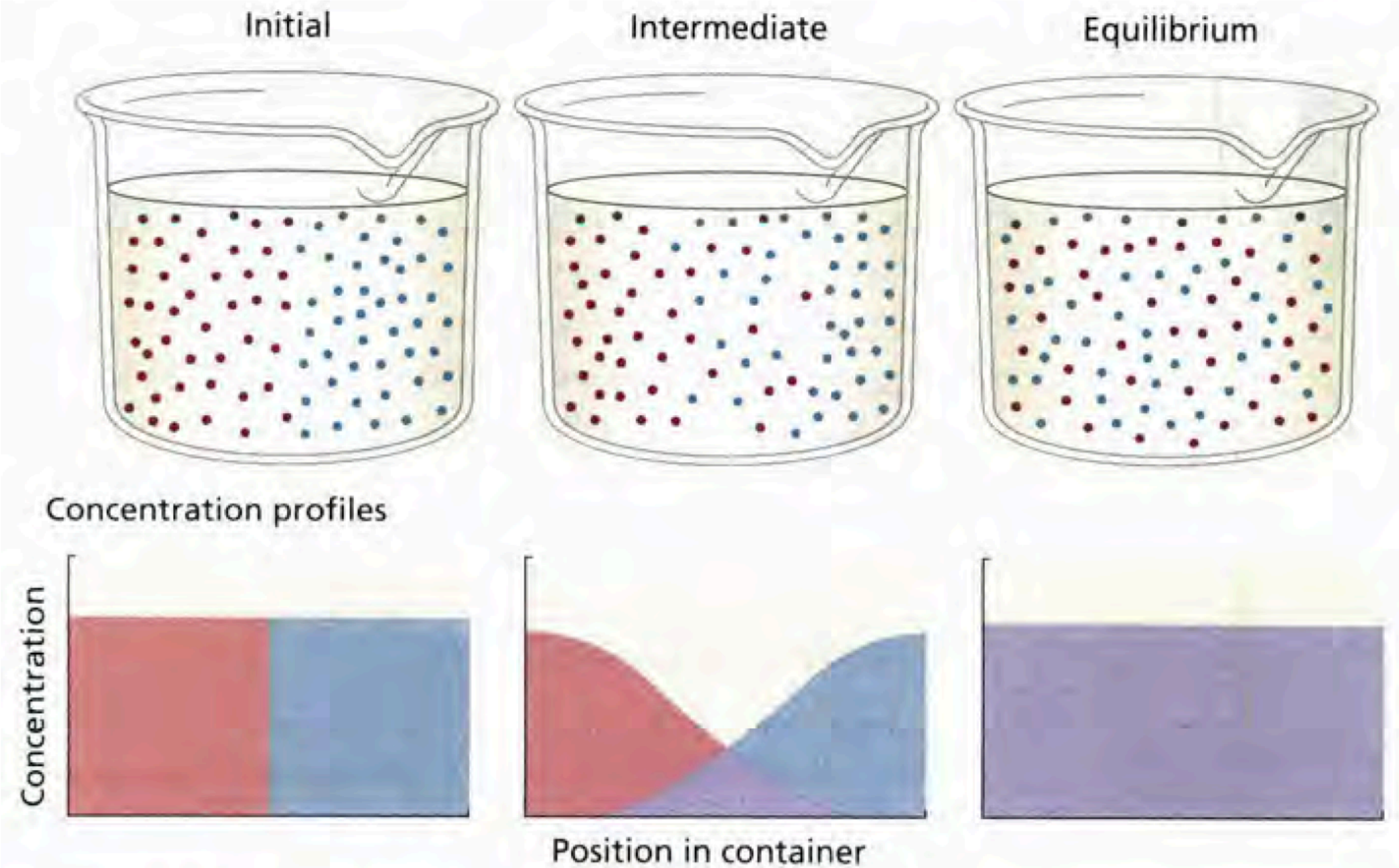


Taiz and Zeiger (2010)

Water

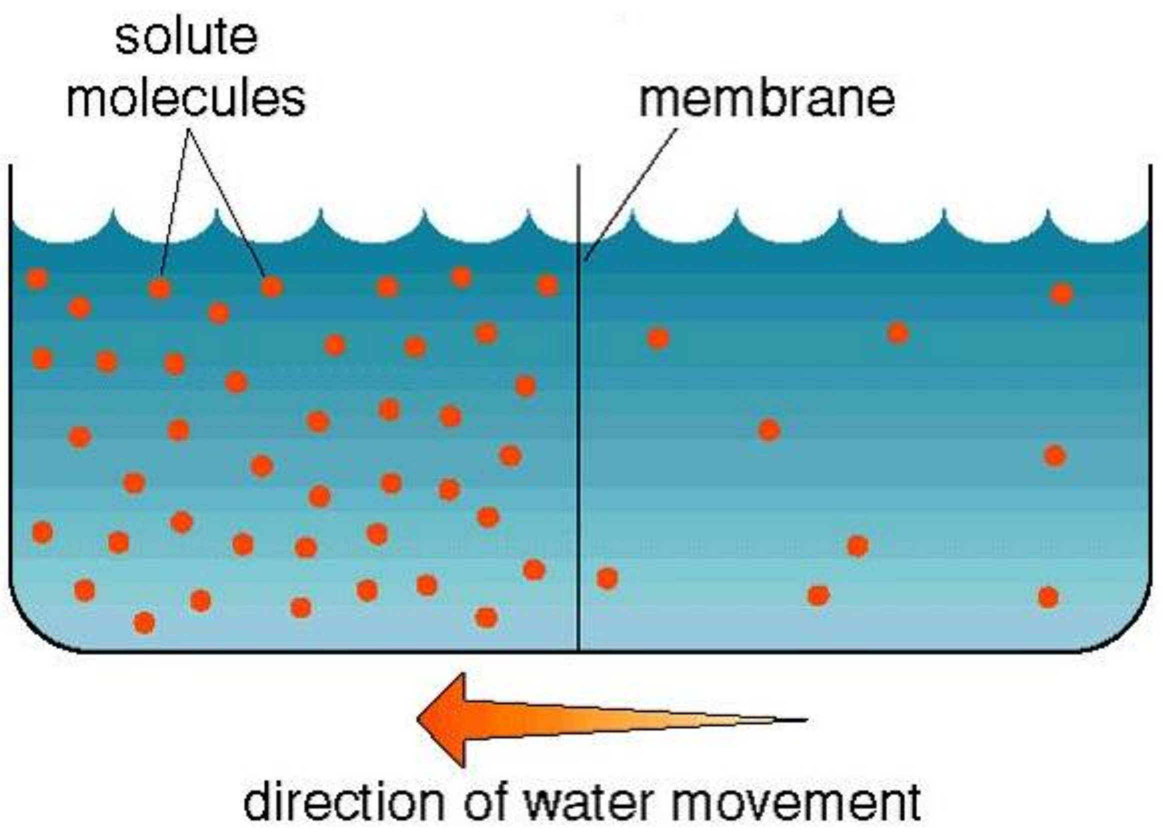
TRANSPORT PROCESSES

Diffusion

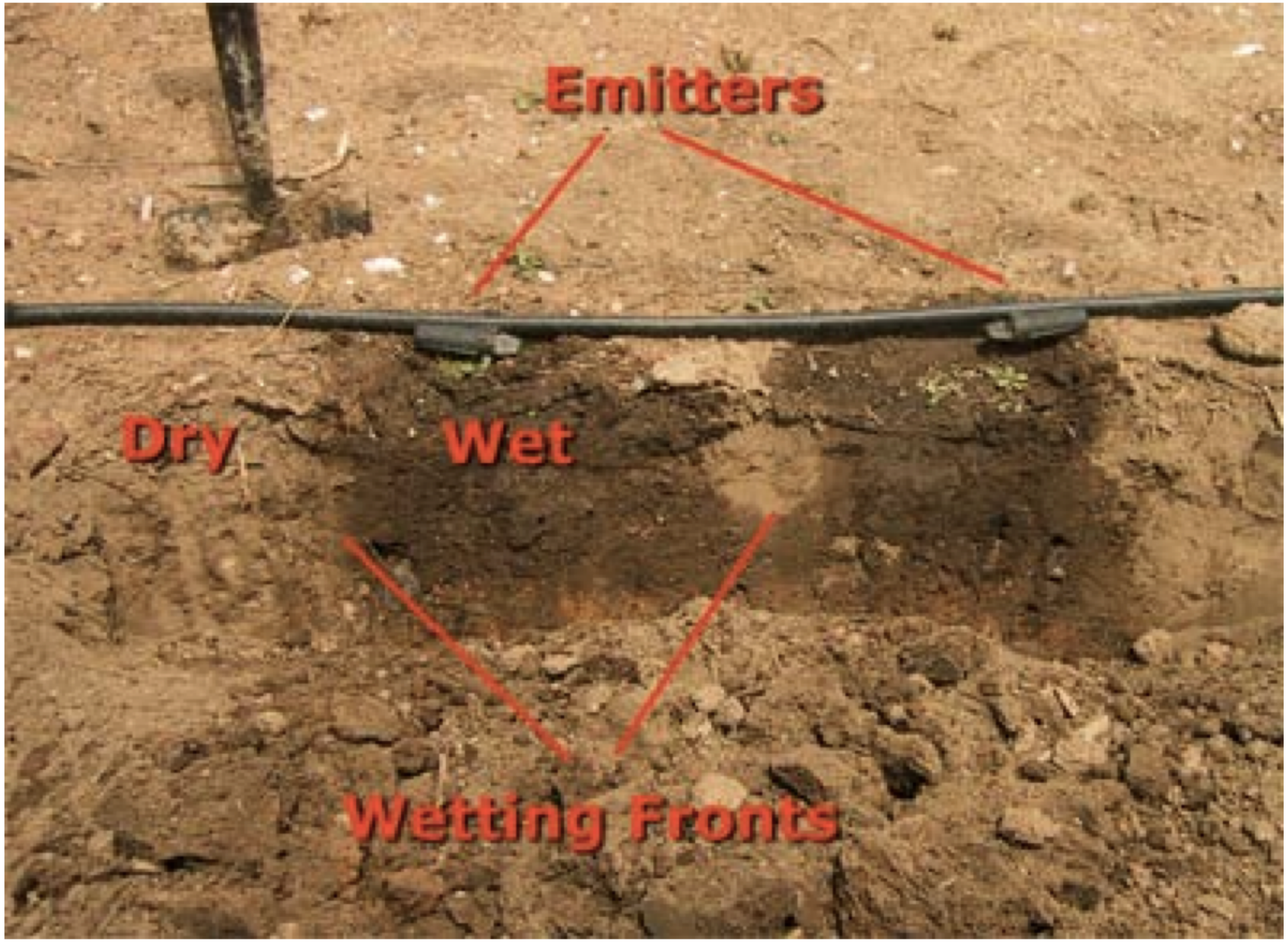


Taiz and Zeiger (2010)

Osmosis



Bulk or mass flow



Water movement through

SOIL-PLANT-ATMOSPHERE CONTINUUM

Water potential (Ψ)

Ψ = 0 MPa

Pure water

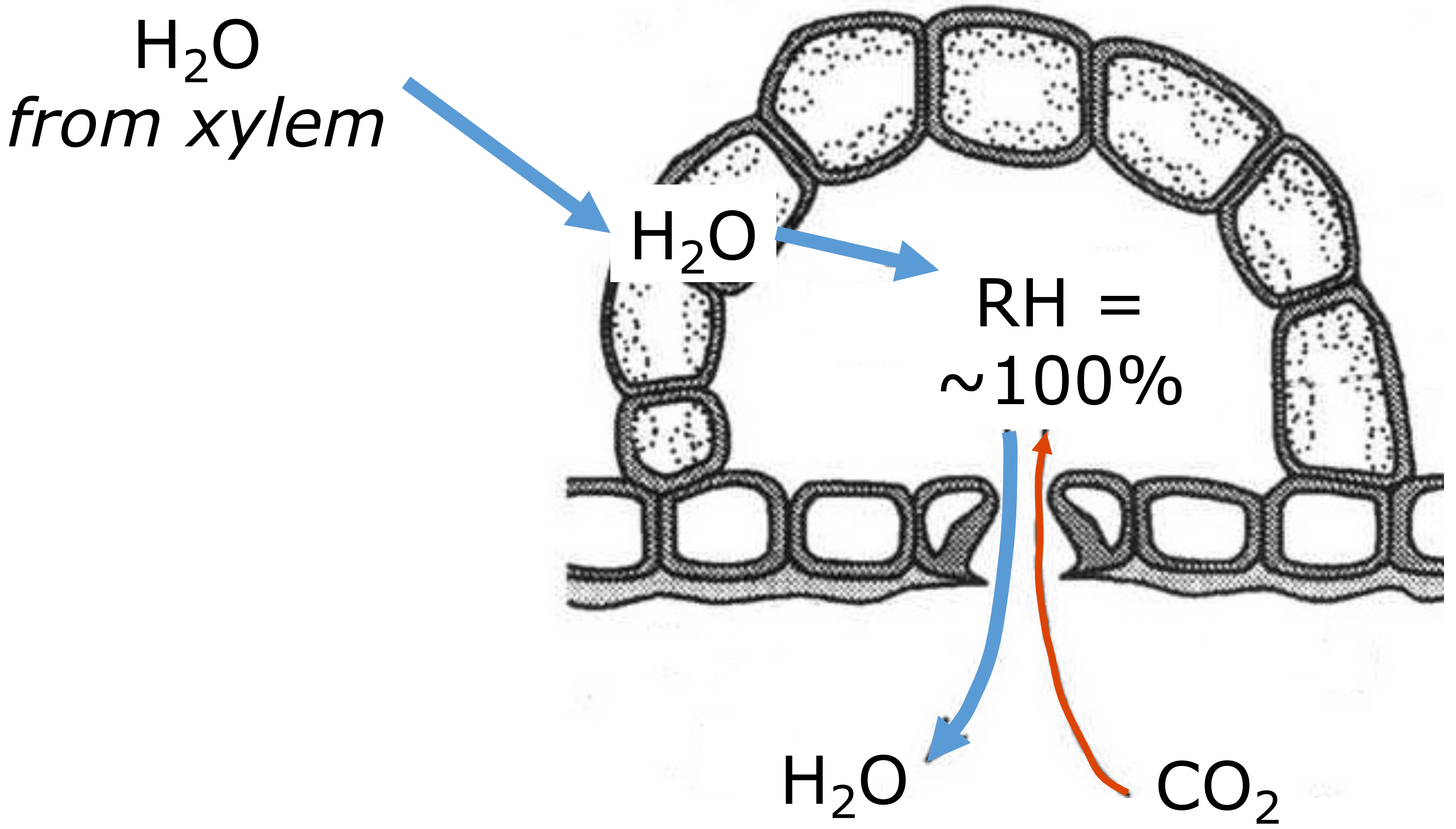
"Water flows downhill"

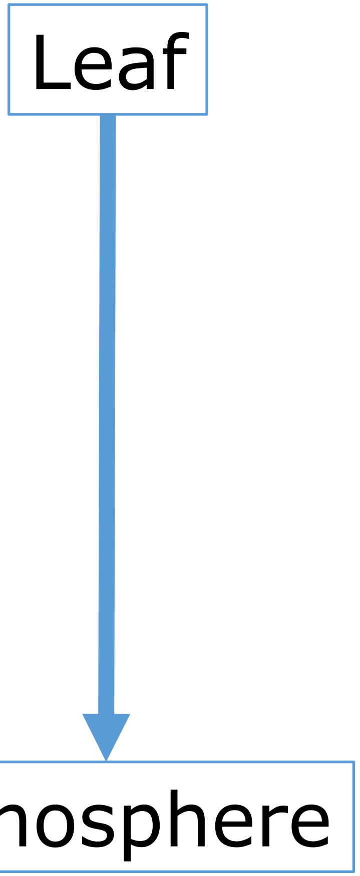
Ψ = -1.0 MPa

Decreasing
potential energy

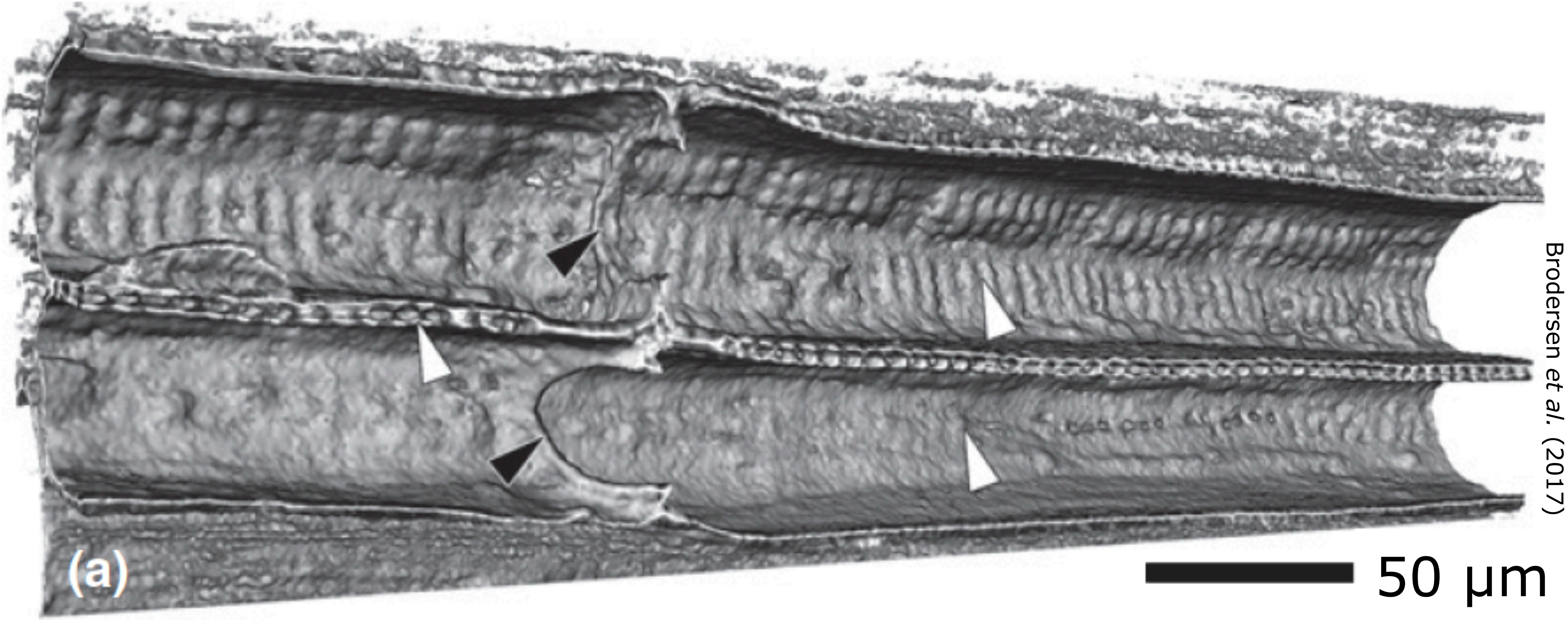
Ψ = -10 MPa

Stomates: connection to atmosphere



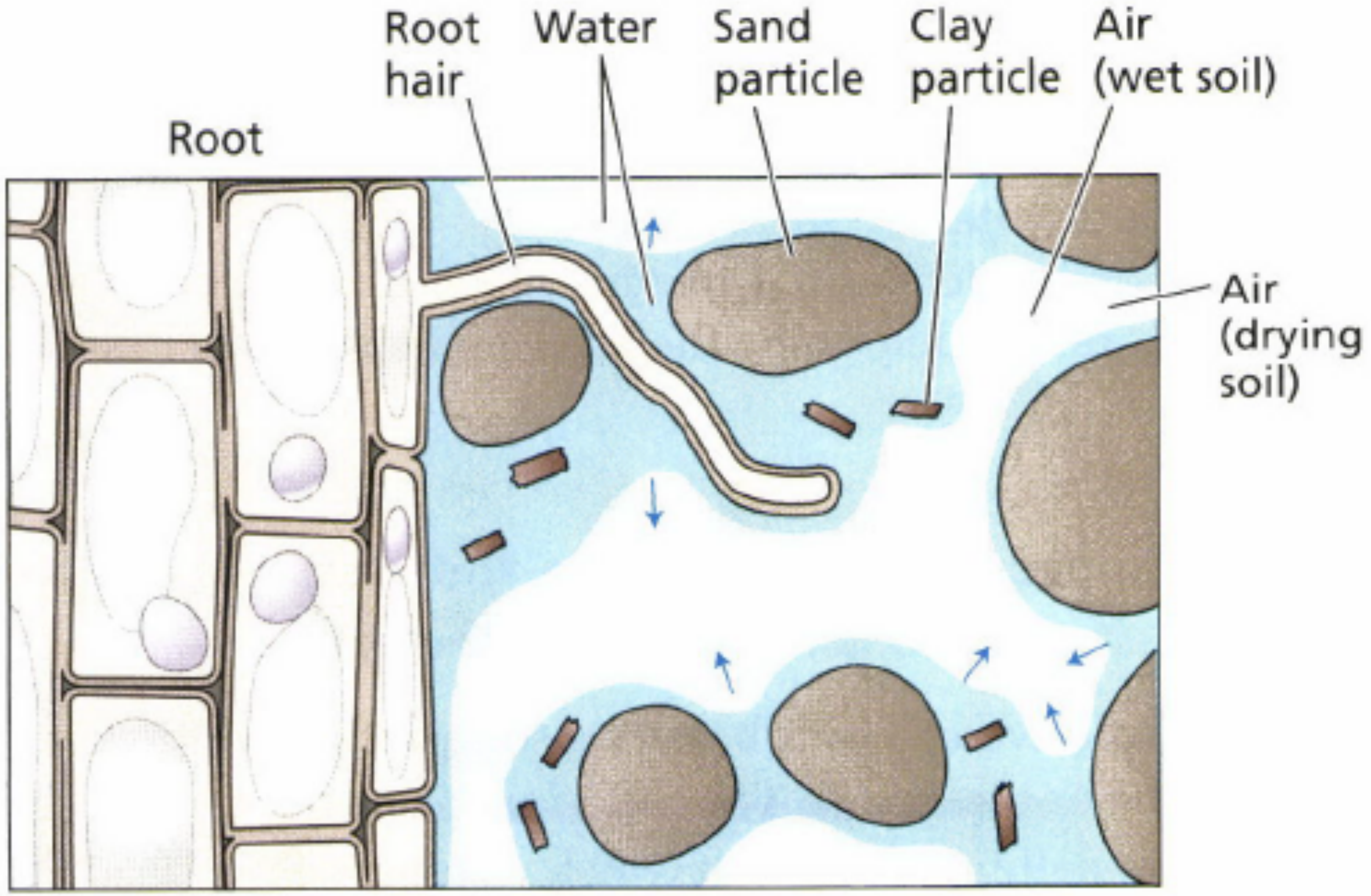


Xylem: specialized pipes

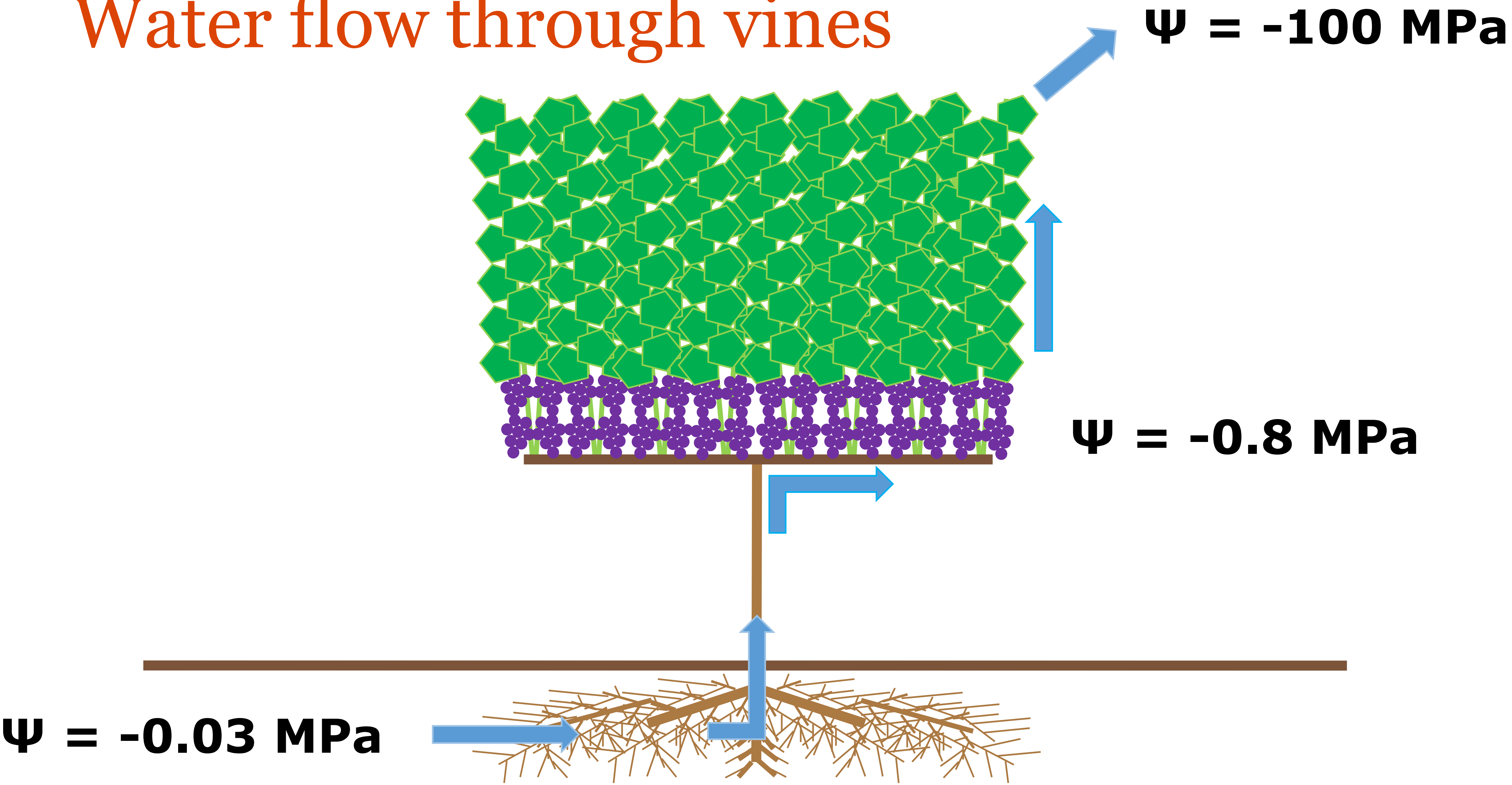


Brodersen *et al.* (2017)

Gradient from soil to root cell

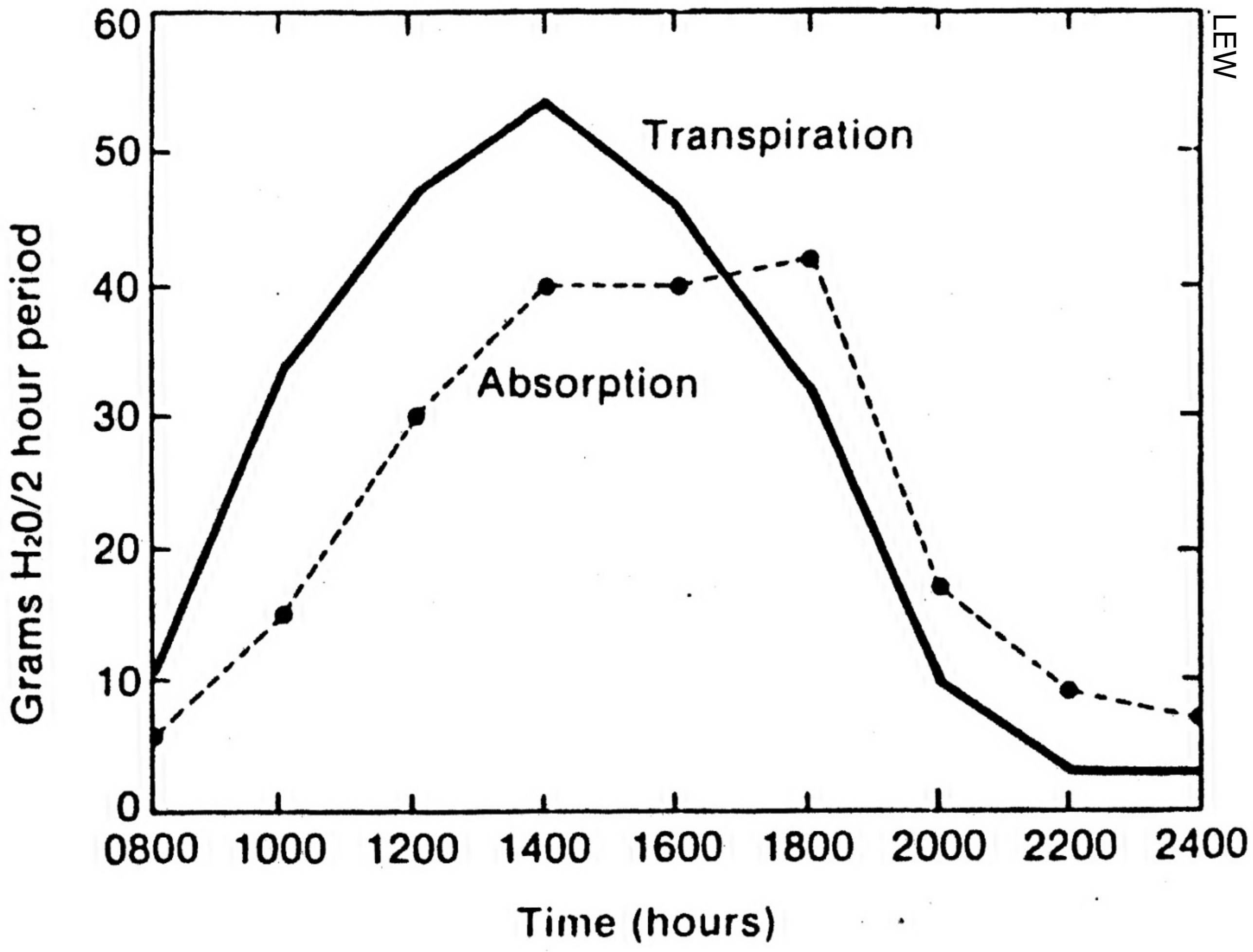


Water flow through vines

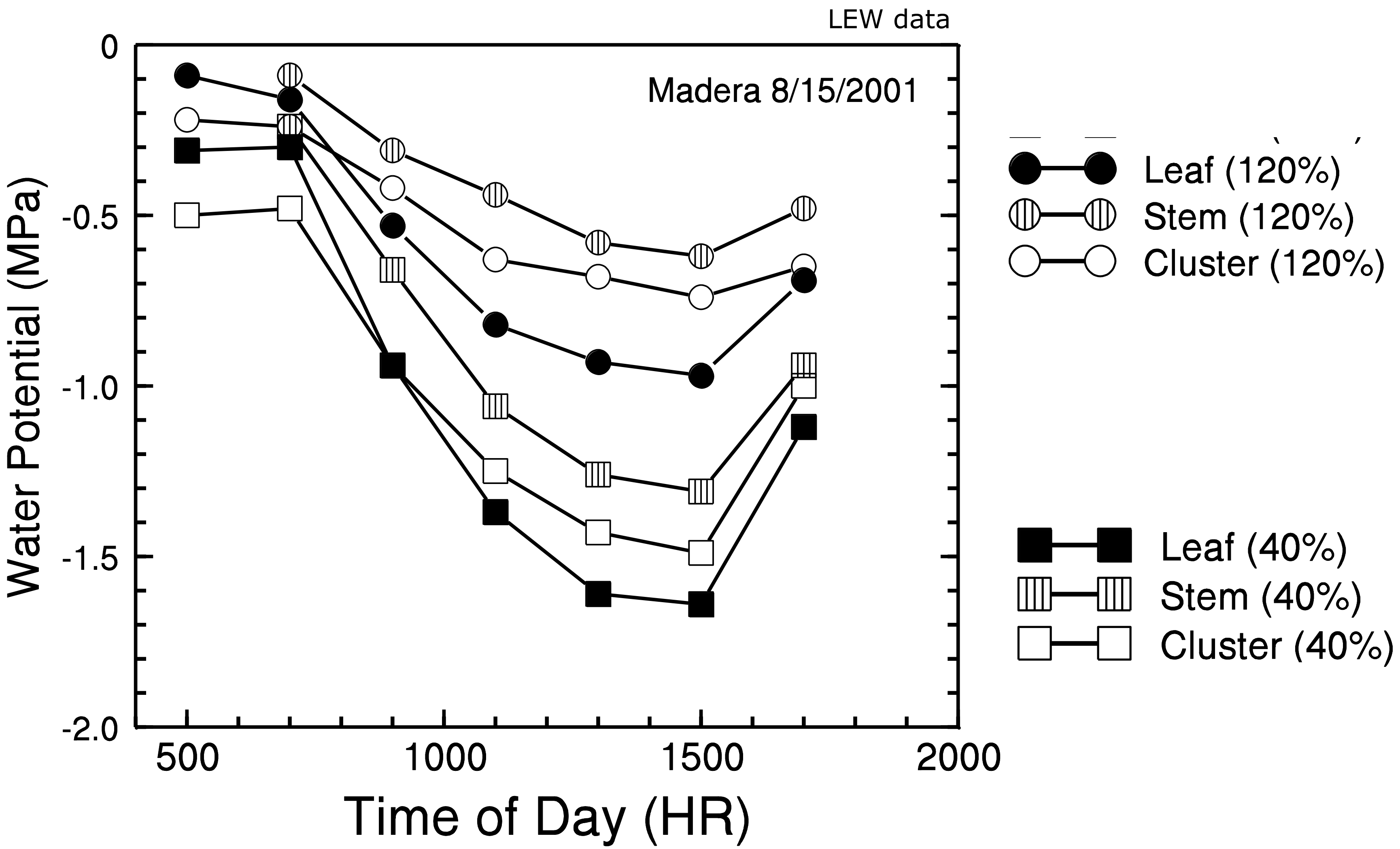


Daily and seasonal
VINE WATER RELATIONS

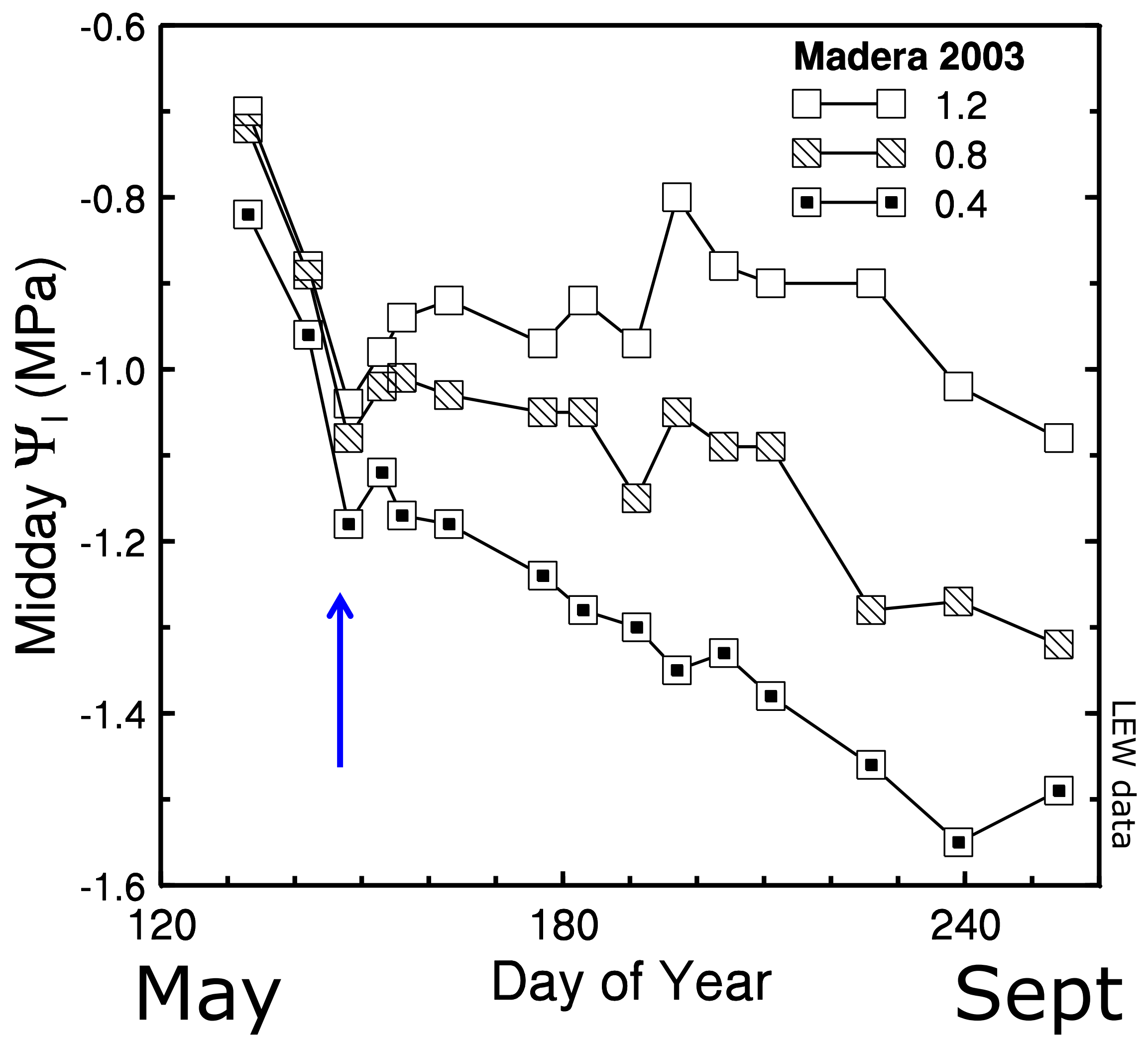
Time lag between water loss and uptake



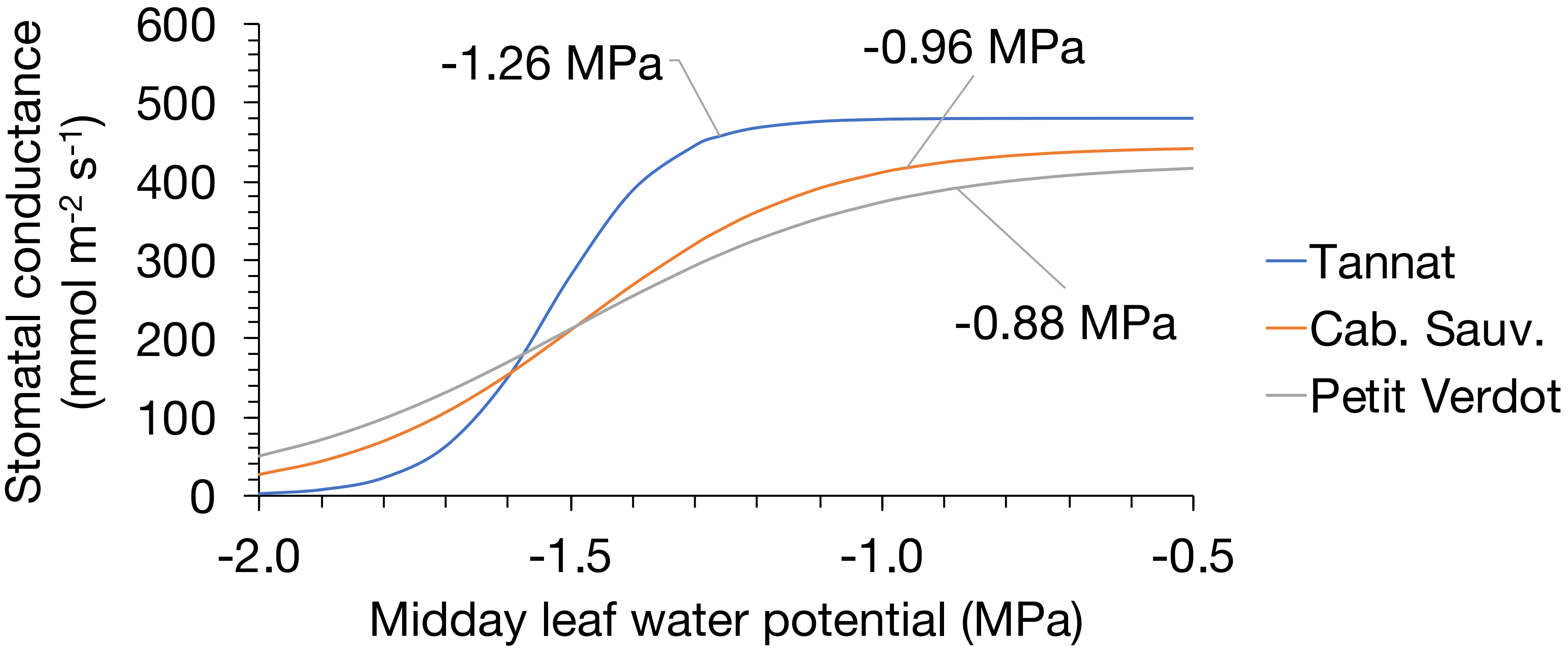
Diurnal course of water potential



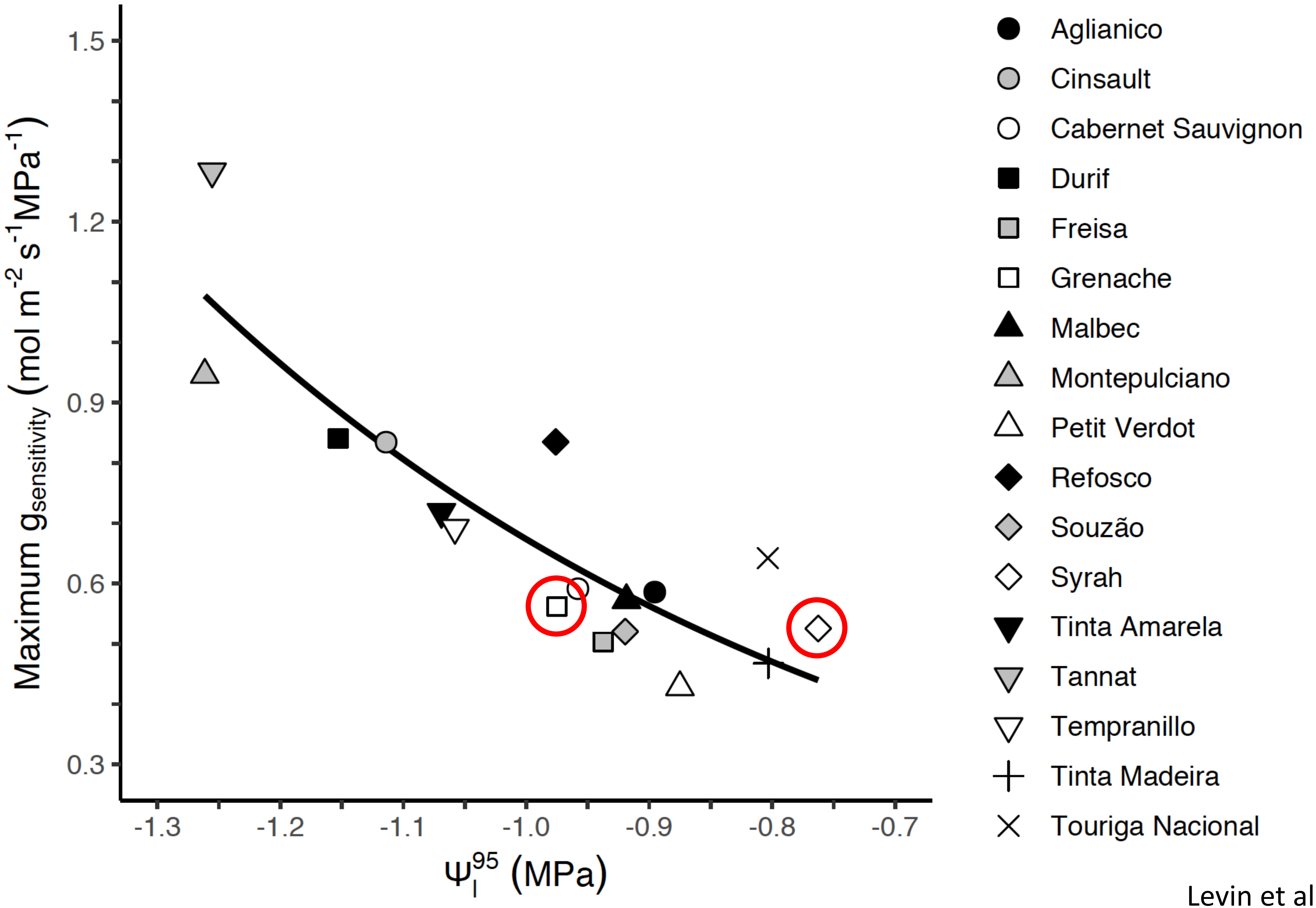
Seasonal course of midday Ψ_{leaf}



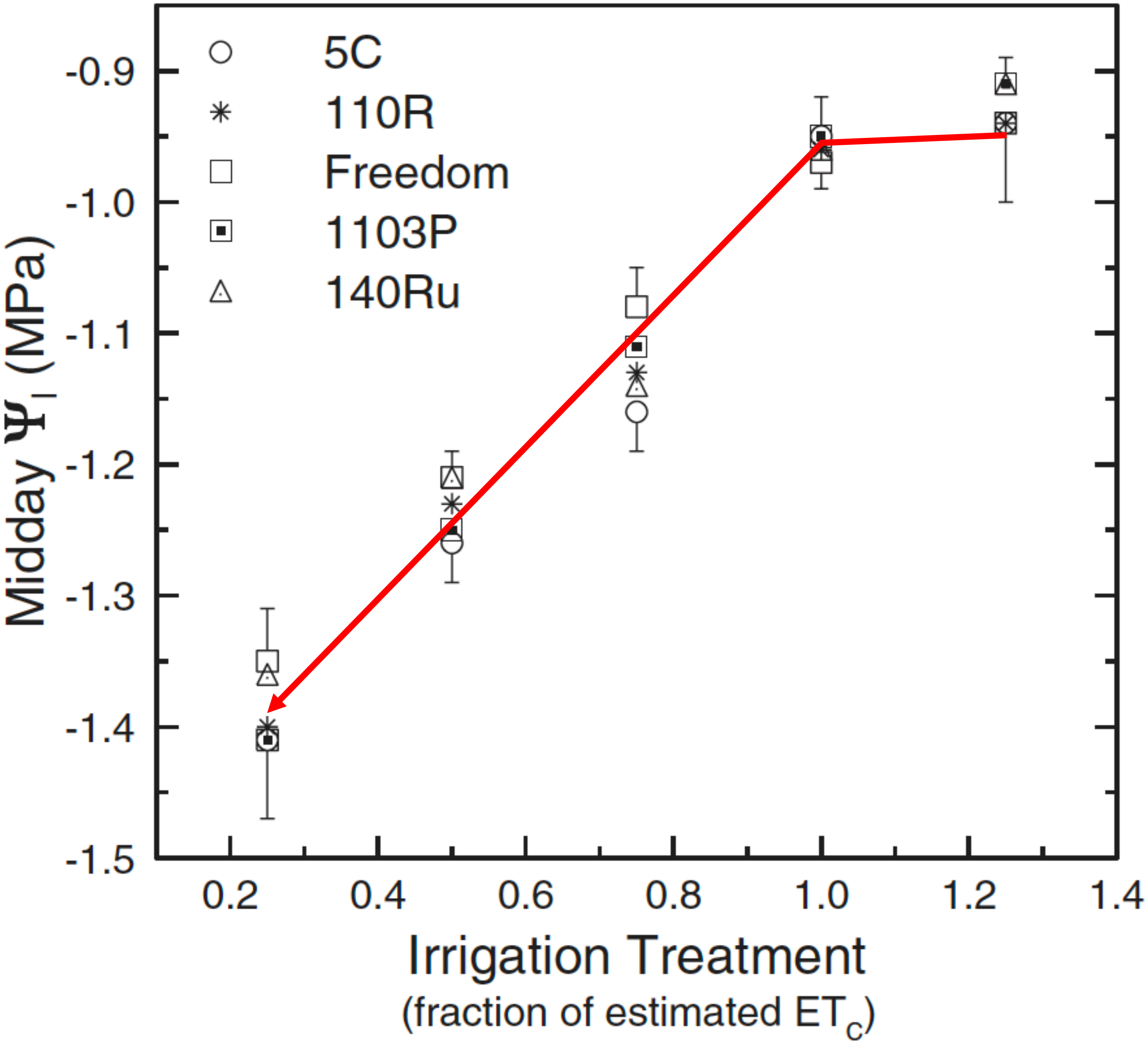
Cultivar-specific stomatal behavior



Levin et al. (*In revision*)



Levin et al. (*In revision*)

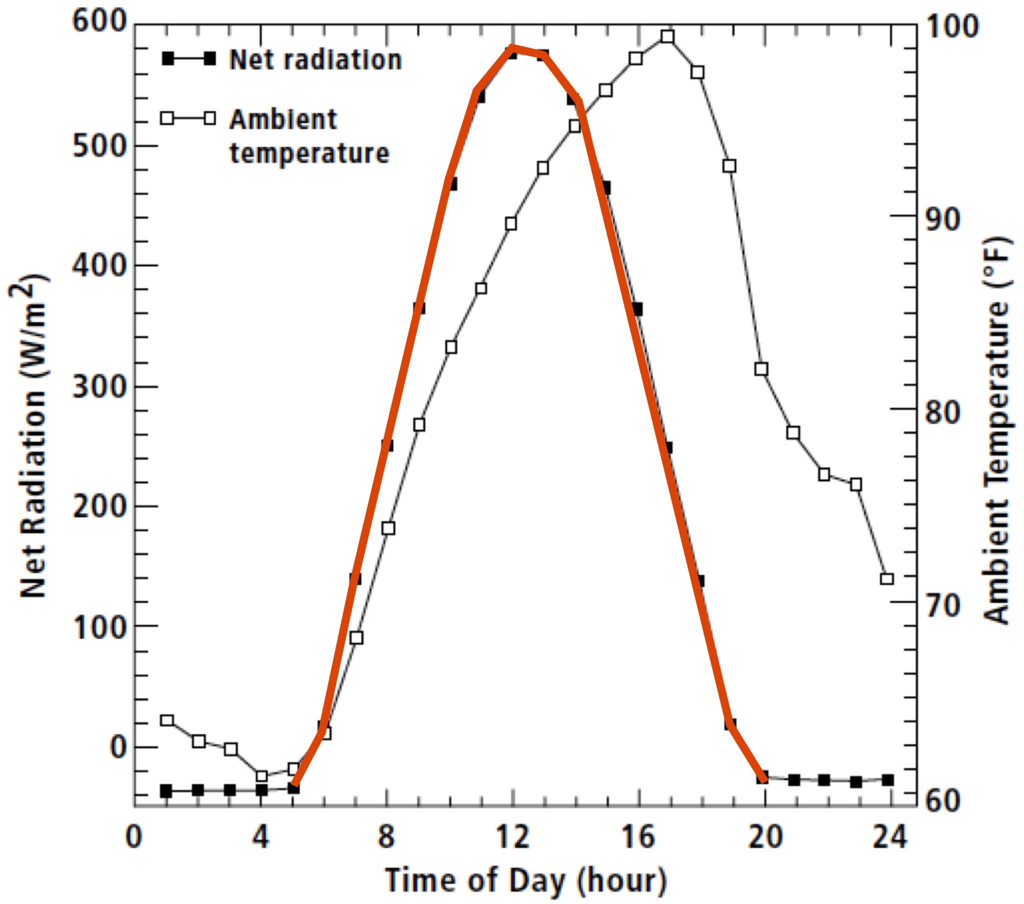


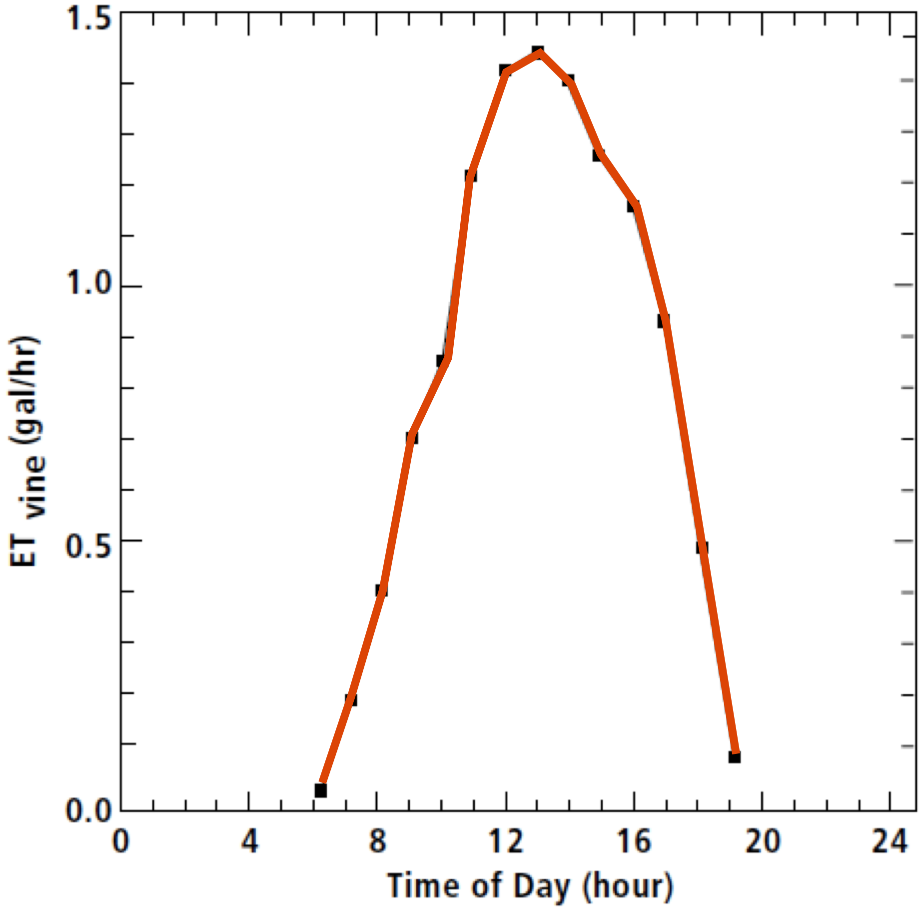
L. E. Williams (2010)

Factors affecting

VINE WATER USE

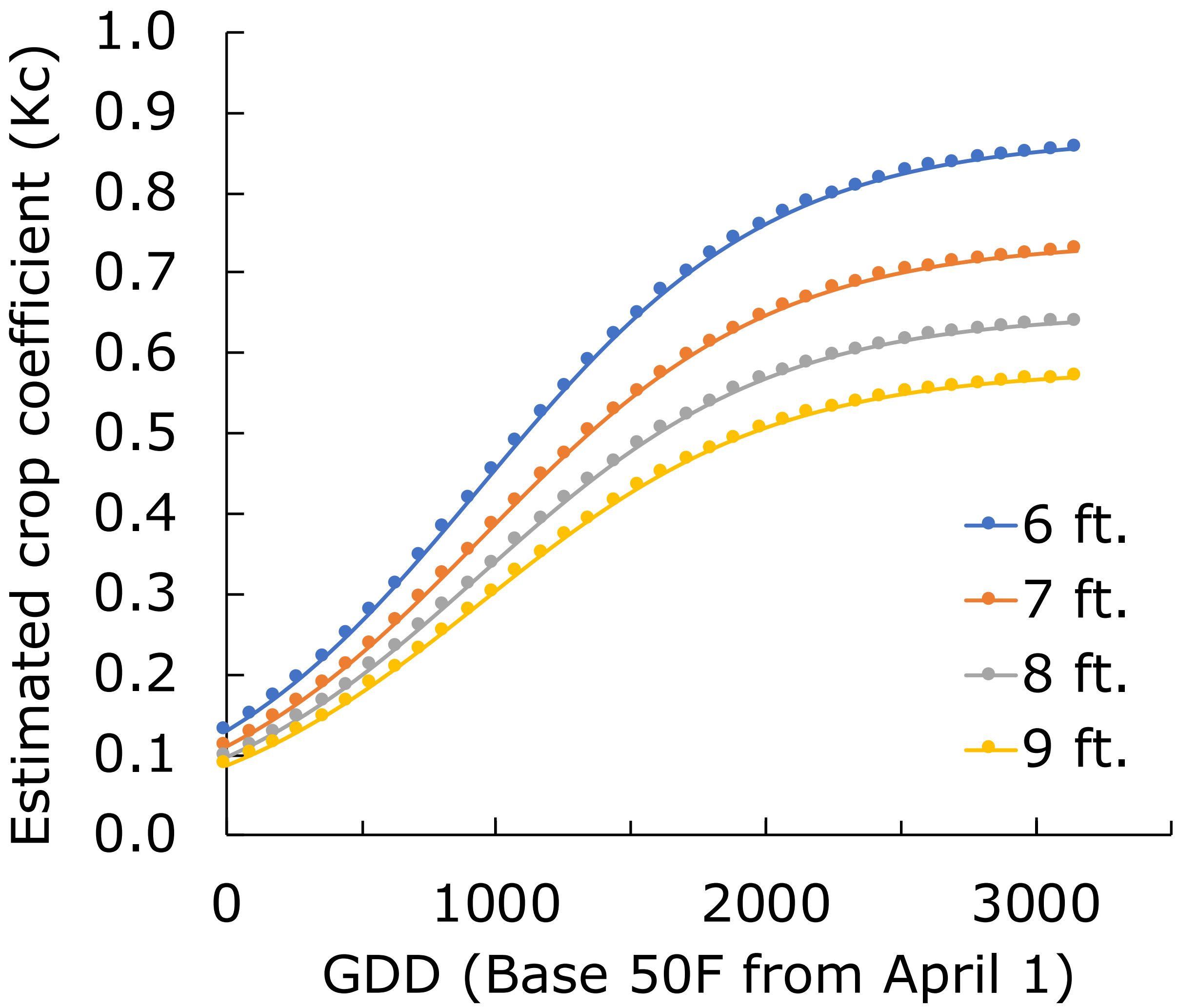
Solar radiation drives vine ET



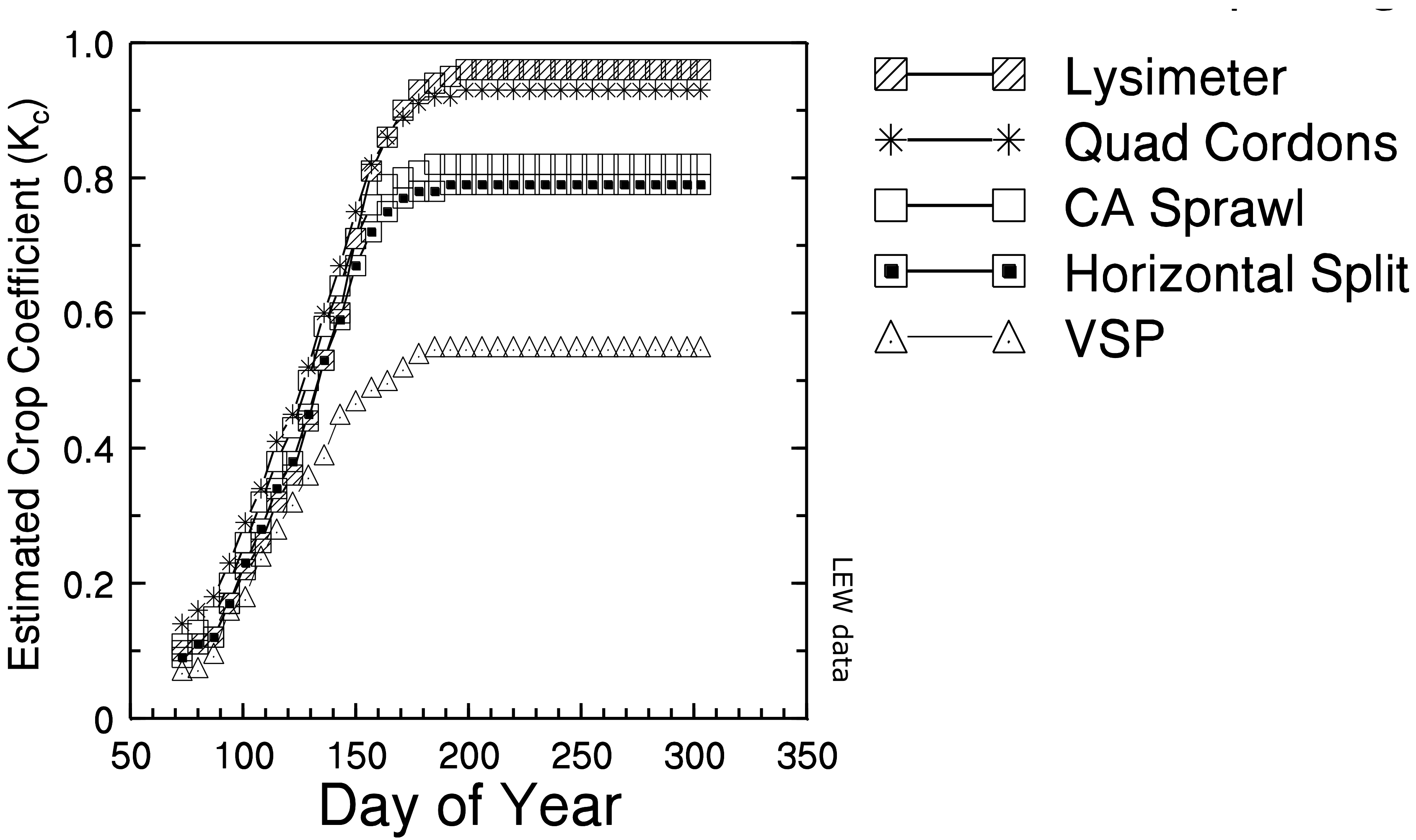


LEW (2000)

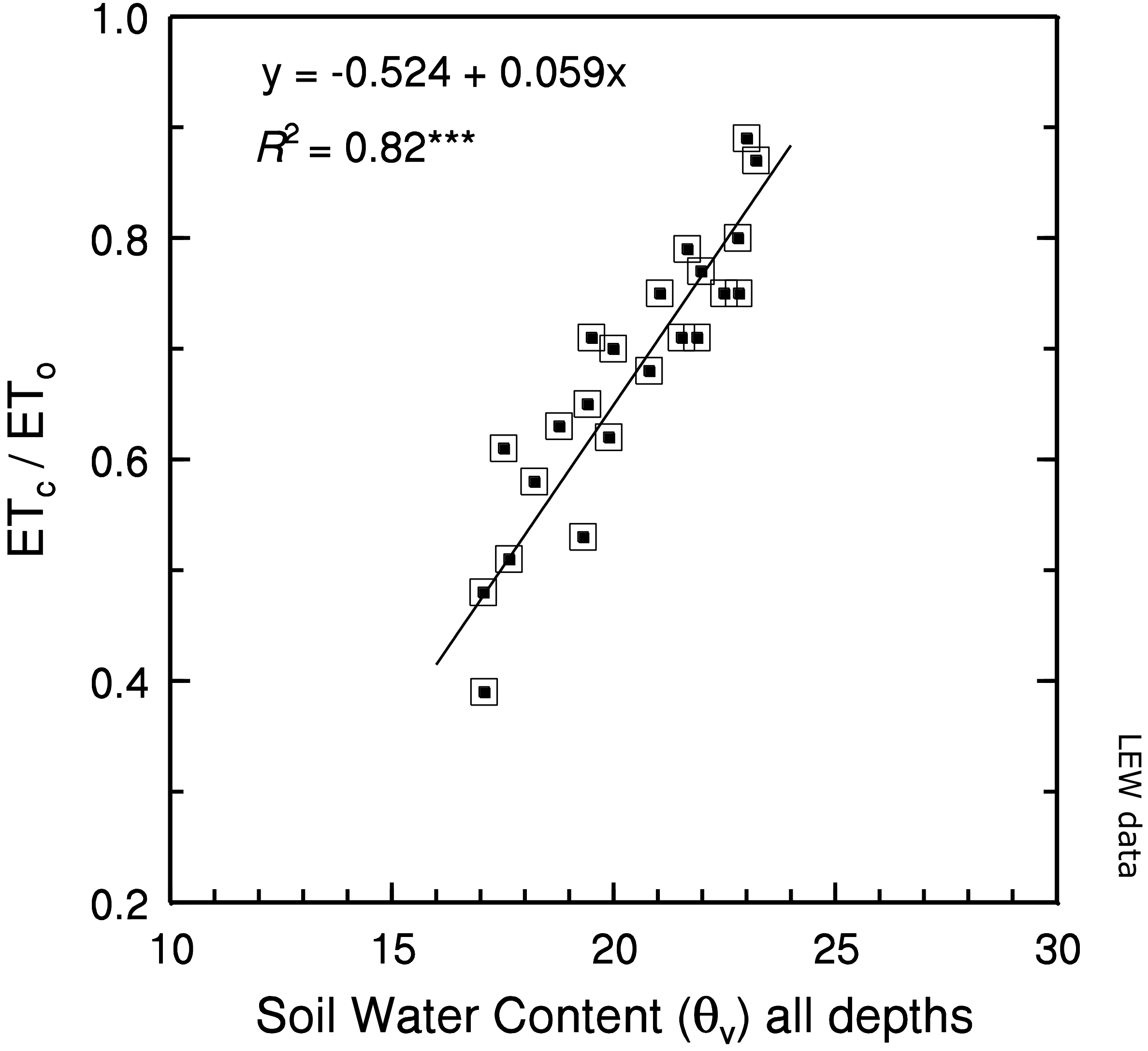
Crop coefficient depends on row spacing

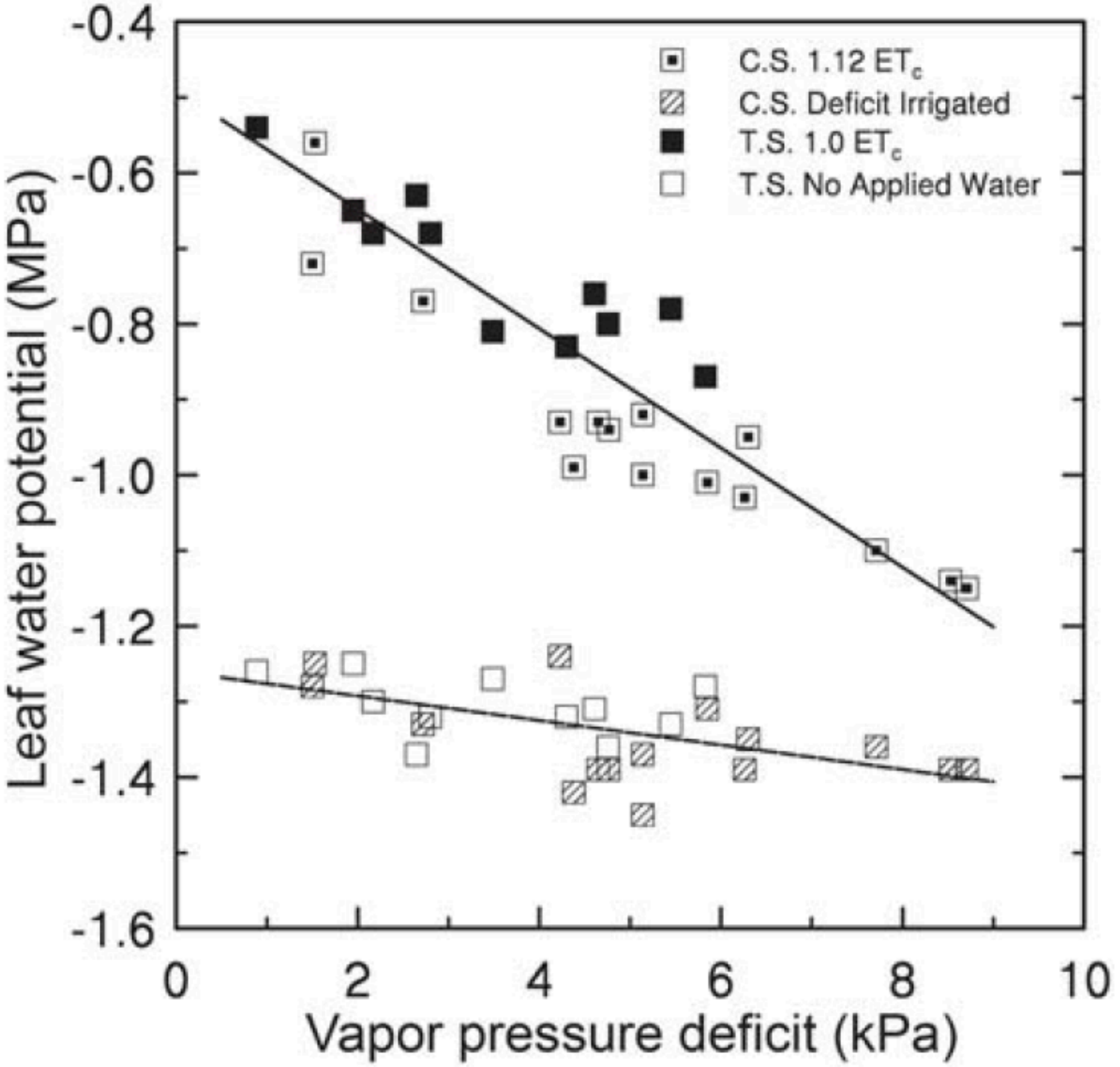


Crop coefficient depends on trellis type

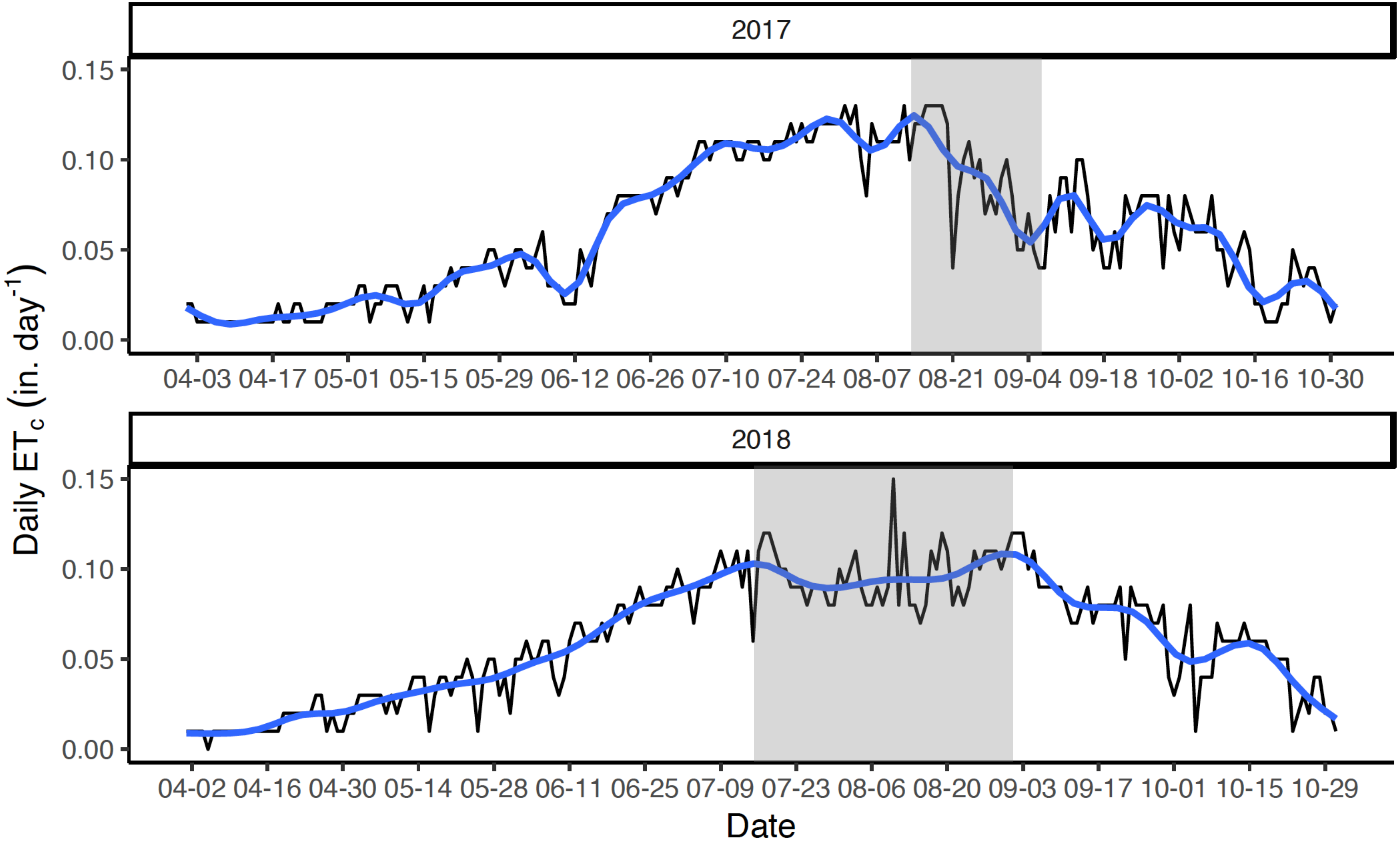


Water use declines with soil water depletion

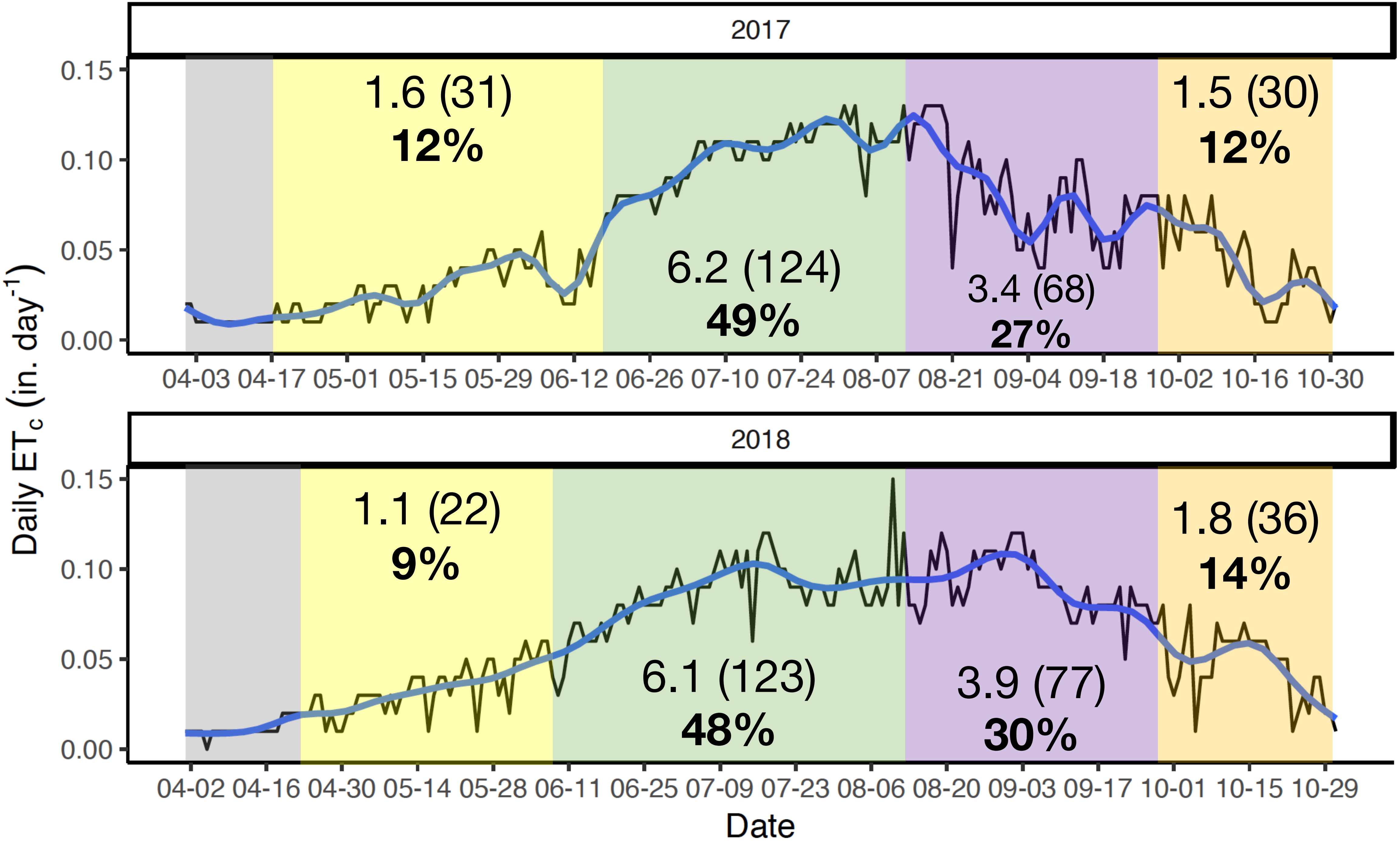




Leaf water potential (MPa)
Vapor pressure deficit (kPa)
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
0
2
4
6
8
10
C.S. 1.12 ET_c
C.S. Deficit Irrigated
T.S. 1.0 ET_c
T.S. No Applied Water



2017
2018
Daily ET_c (in. day^{-1})
0.00
0.05
0.10
0.15
04-03 04-17 05-01 05-15 05-29 06-12 06-26 07-10 07-24 08-07 08-21 09-04 09-18 10-02 10-16 10-30
04-02 04-16 04-30 05-14 05-28 06-11 06-25 07-09 07-23 08-06 08-20 09-03 09-17 10-01 10-15 10-29
Date


2017
2018
Daily ET_c (in. day^{-1})
Date
1.6 (31)
12%
6.2 (124)
49%
3.4 (68)
27%
1.5 (30)
12%
1.1 (22)
9%
6.1 (123)
48%
3.9 (77)
30%
1.8 (36)
14%
0.00
0.05
0.10
0.15
04-03 04-17 05-01 05-15 05-29 06-12 06-26 07-10 07-24 08-07 08-21 09-04 09-18 10-02 10-16 10-30
04-02 04-16 04-30 05-14 05-28 06-11 06-25 07-09 07-23 08-06 08-20 09-03 09-17 10-01 10-15 10-29

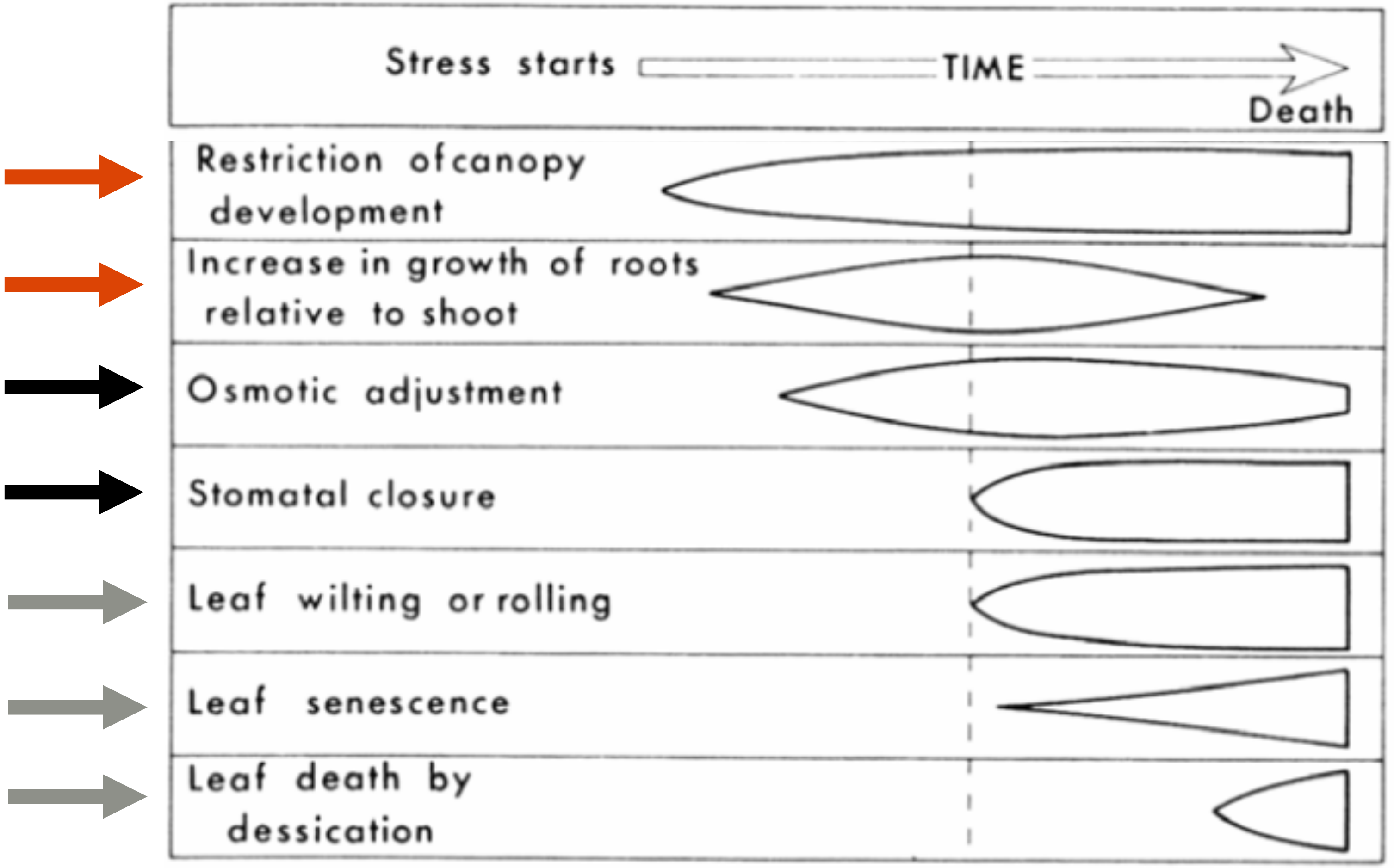
Effects of water deficits on
VEGETATIVE GROWTH

General plant response to water stress

Growth adjustment

“Drought management”

“Drought escape”



Bradford and Hsiao 1982

Rating tendrils

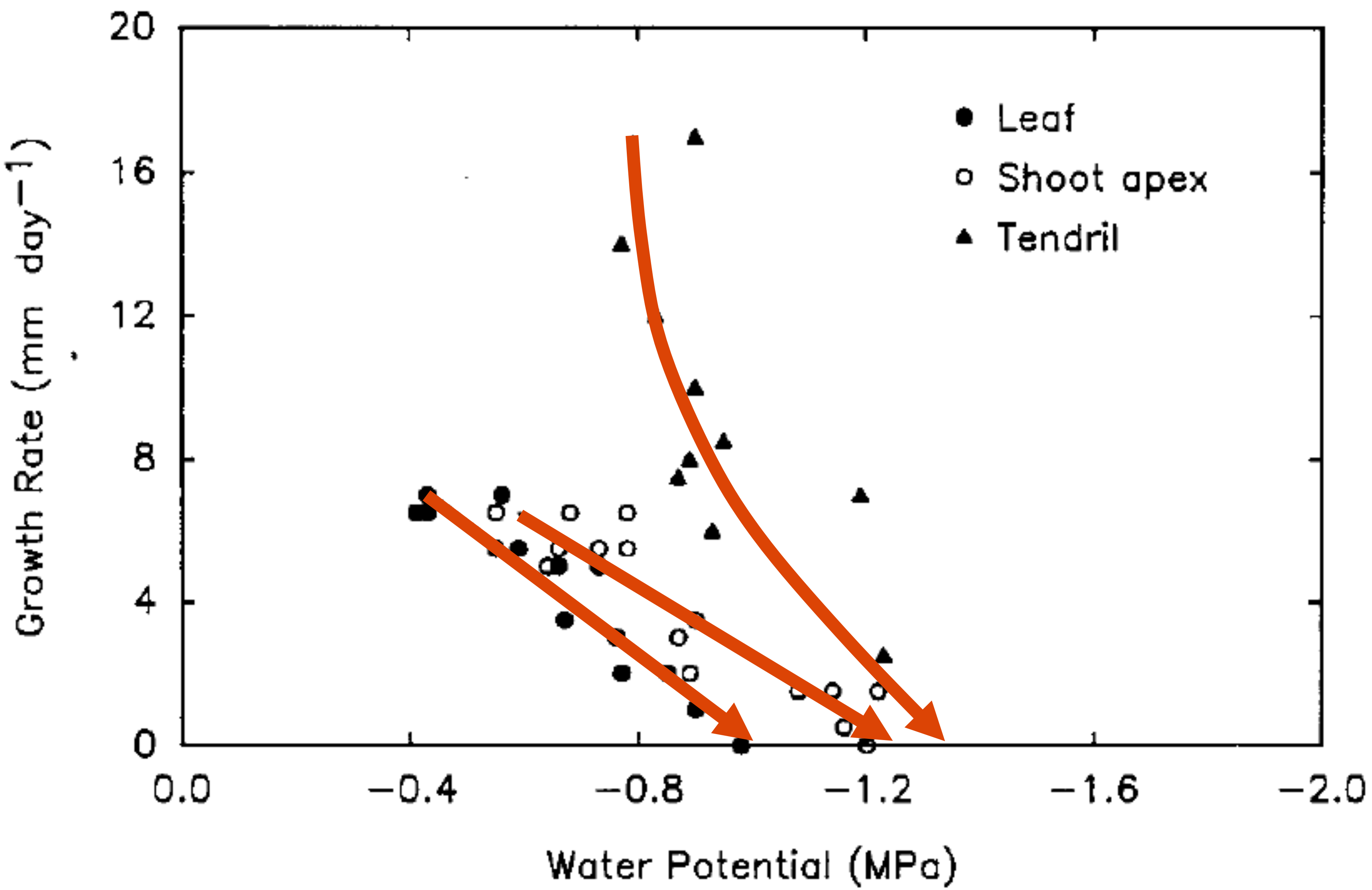
Photo by AD Levin

Rating shoot tips

Rapid Growth | Slowing Growth | Almost Stopped | Stopped | Dead Tip

Photo by Advanced Viticulture, Inc.

Effects of water stress on organ growth



Growth most sensitive in:

1. Tendrils
2. Leaves
3. Internodes

Growth stops at:

-10 bars for leaves

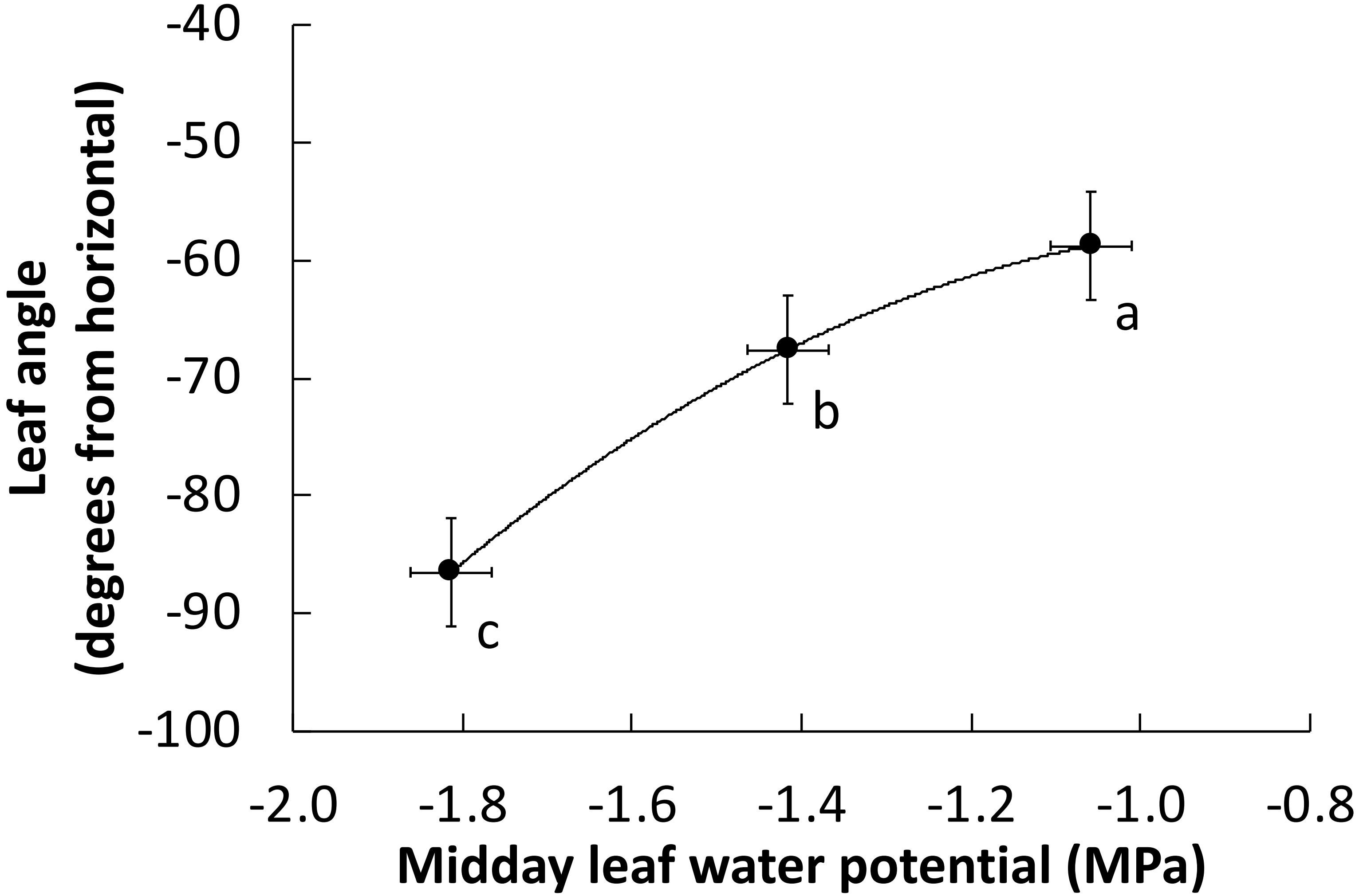
-12 bars for internodes

-13 bars for tendrils

Schultz and Matthews 1988

Leaf angle and sun avoidance

Effect of water potential on leaf angle



Levin et al (unpublished data)

Effect of cultivar on leaf angle

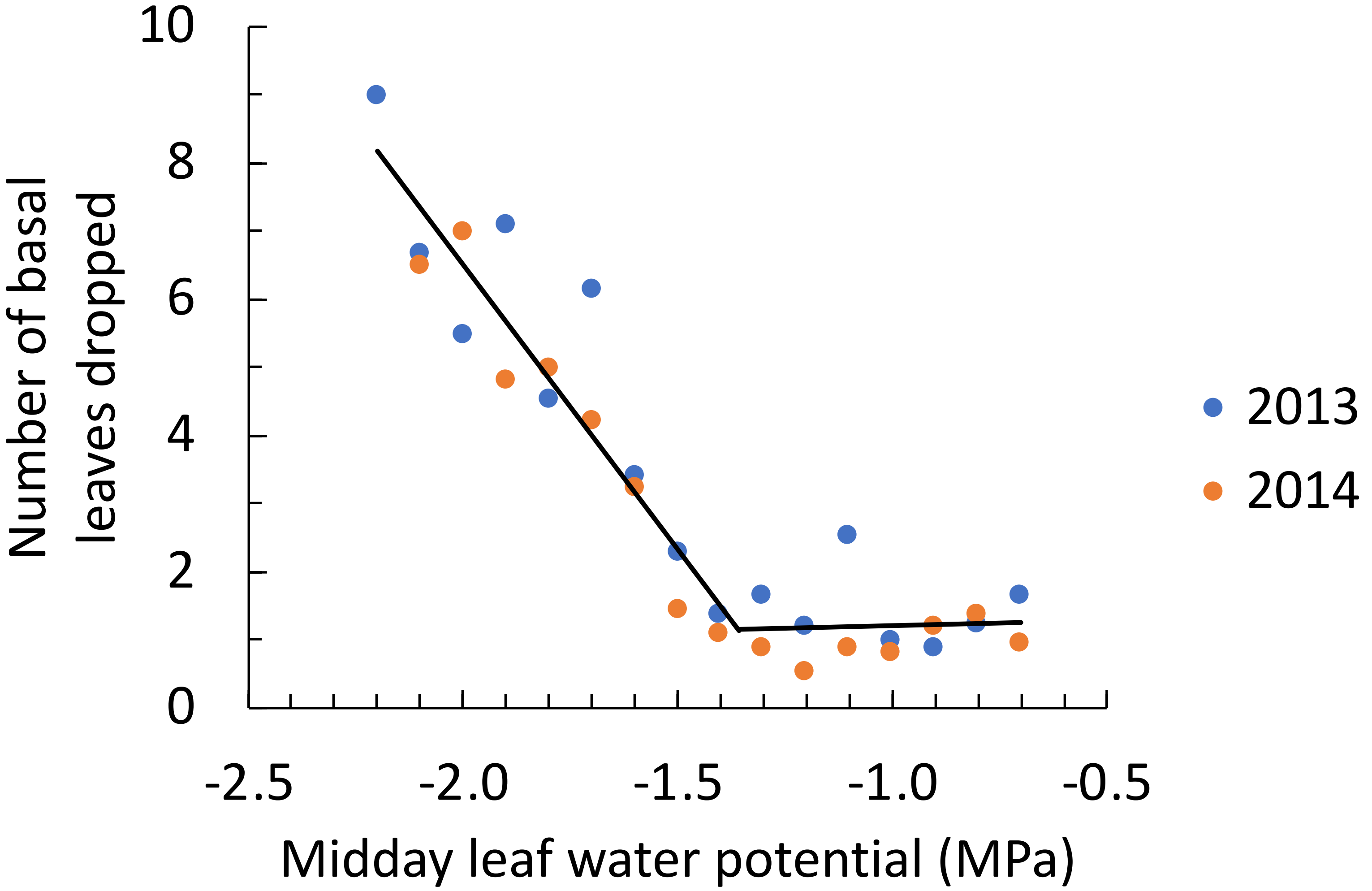
Cultivar	Leaf angle (degrees from horizontal)
Freisa	-78.6 c
Petit Verdot	-77.3 c
Souzão	-77.3 c
Refosco	-76.4 c
Touriga Nacional	-73.5 bc
Tempranillo	-72.9 abc
Grenache noir	-69.0 abc
Syrah	-66.8 abc
Tannat	-59.7 ab
Cabernet Sauvignon	-58.0 a

More Horizontal or erect

Levin et al (unpublished data)

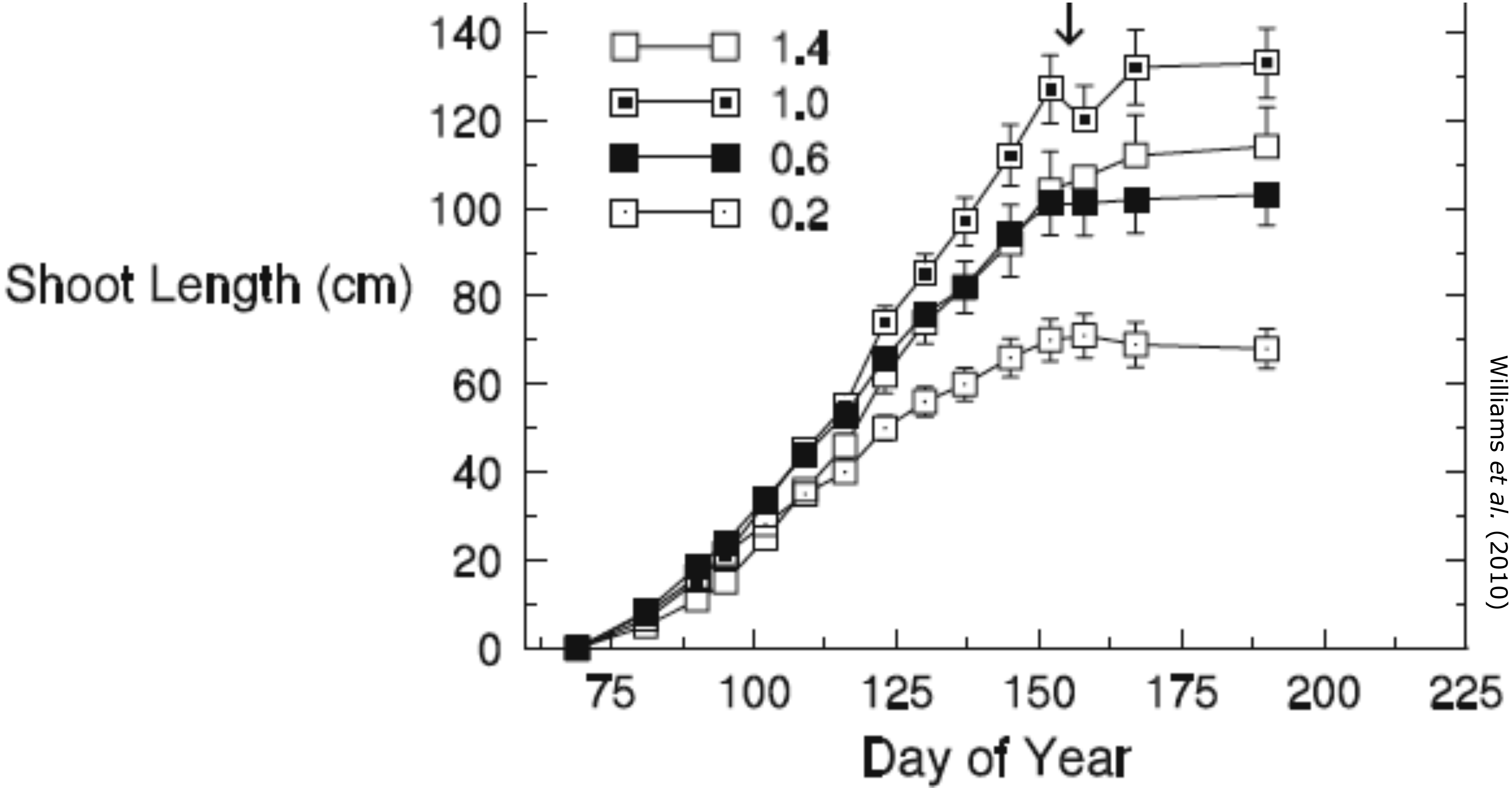
Leaf senescence and desiccation

Effect of water potential on leaf drop



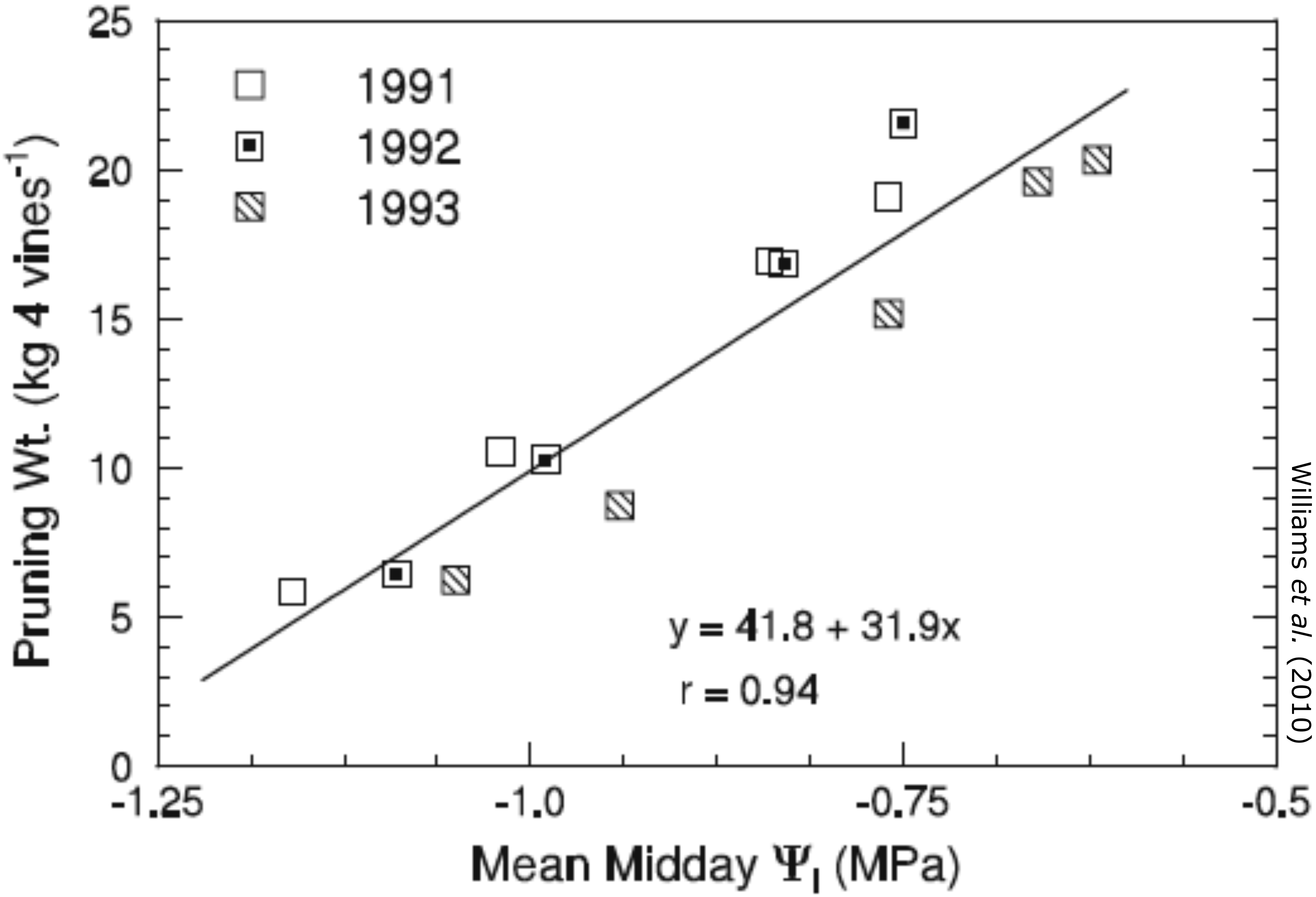
Levin et al (unpublished data)

Water deficits reduce shoot growth



Williams *et al.* (2010)

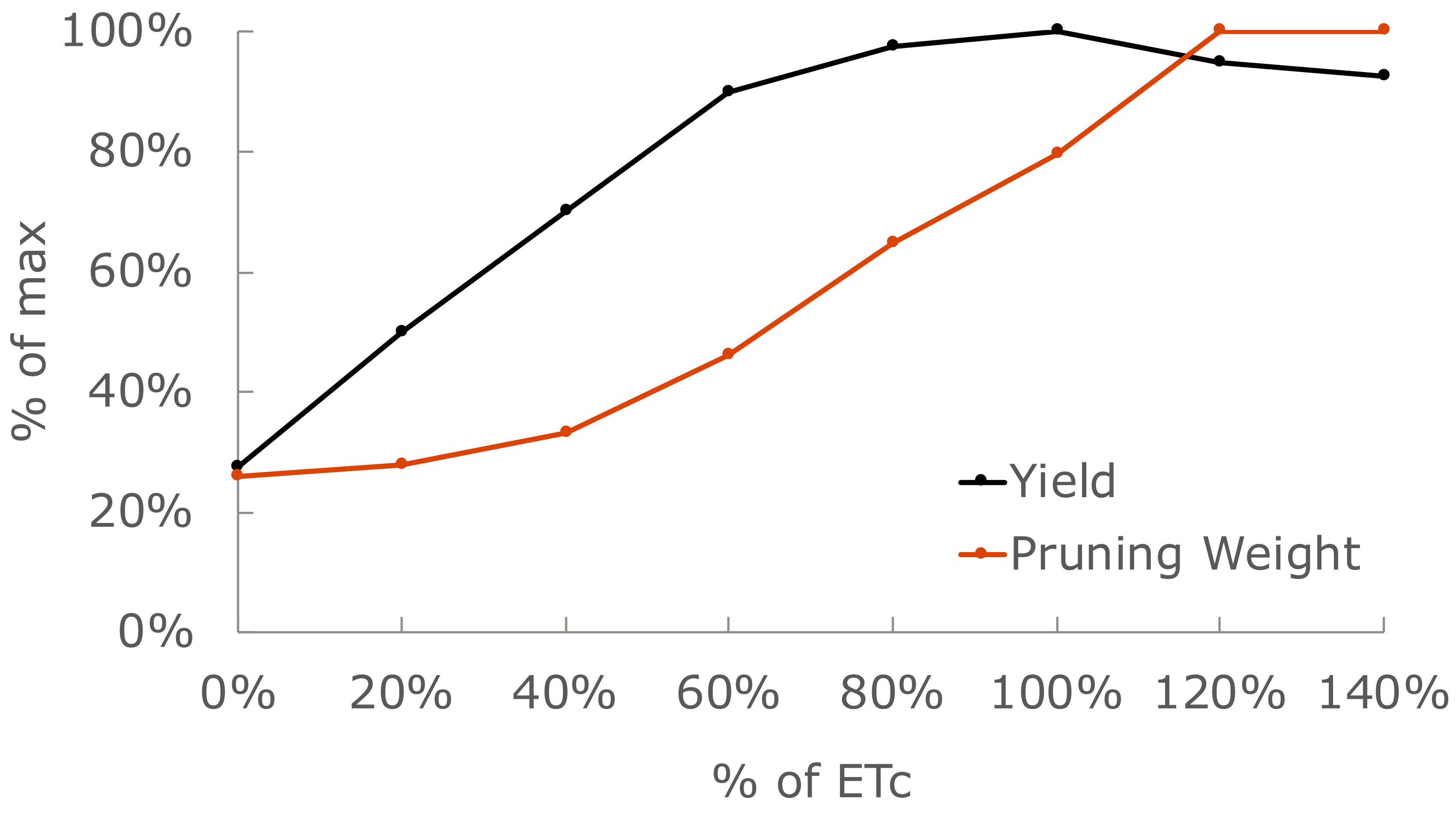
Pruning weight response to midday Ψ_{leaf}



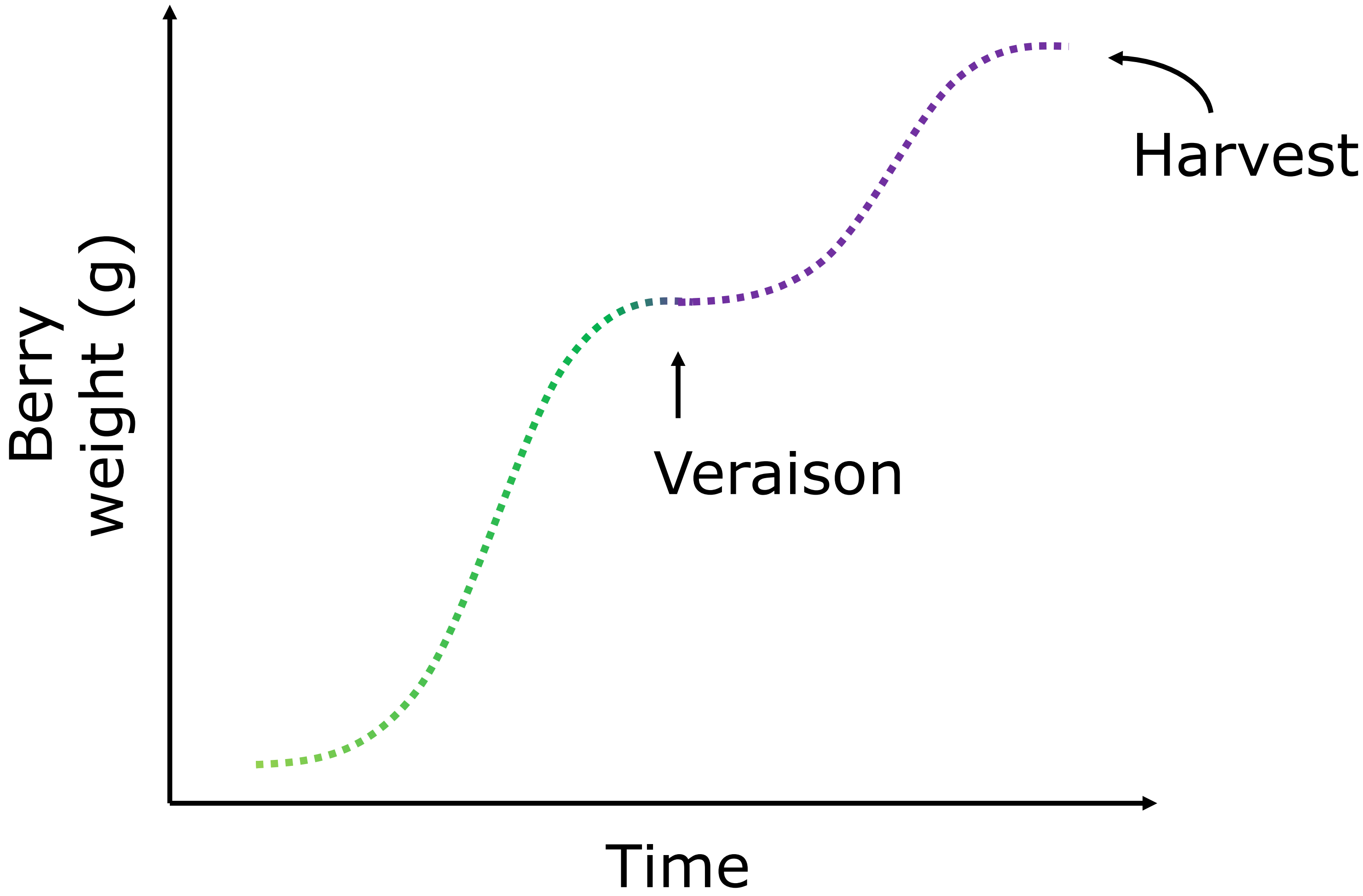
Williams *et al.* (2010)

Effects of water deficits on
REPRODUCTIVE GROWTH

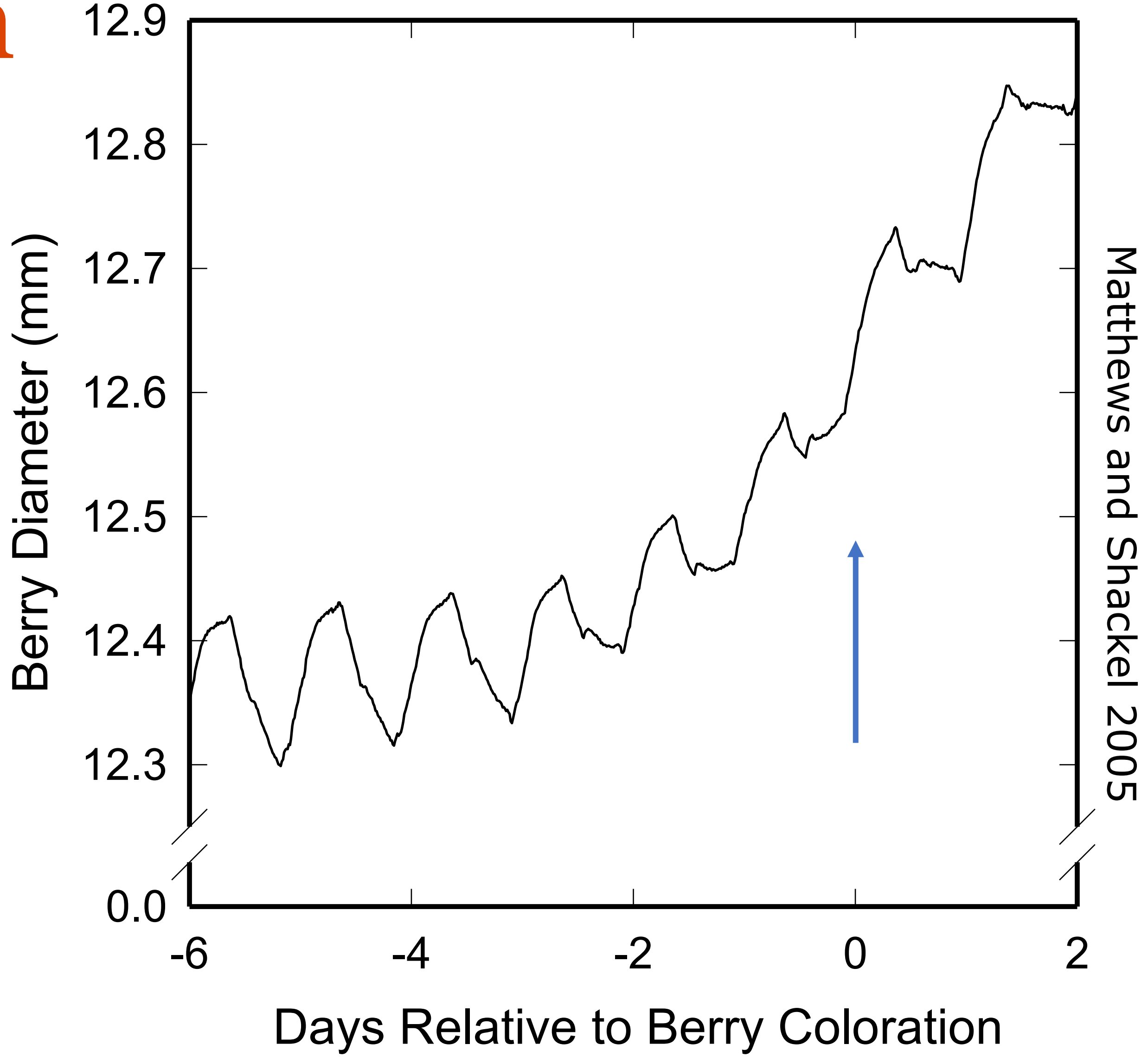
Reproductive growth is less sensitive



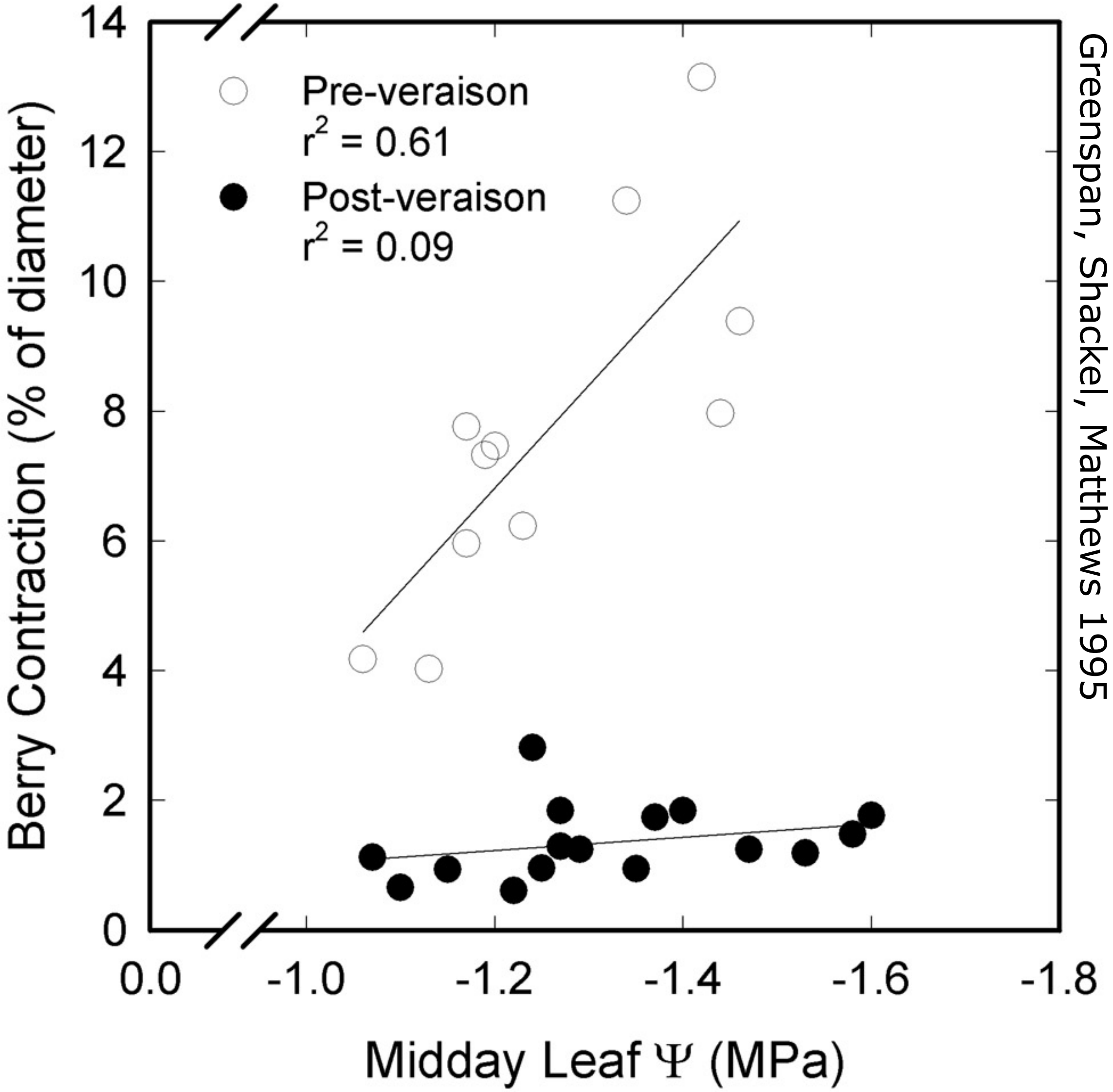
Berry growth occurs in two phases



Diurnal berry contraction pre- and postveraison

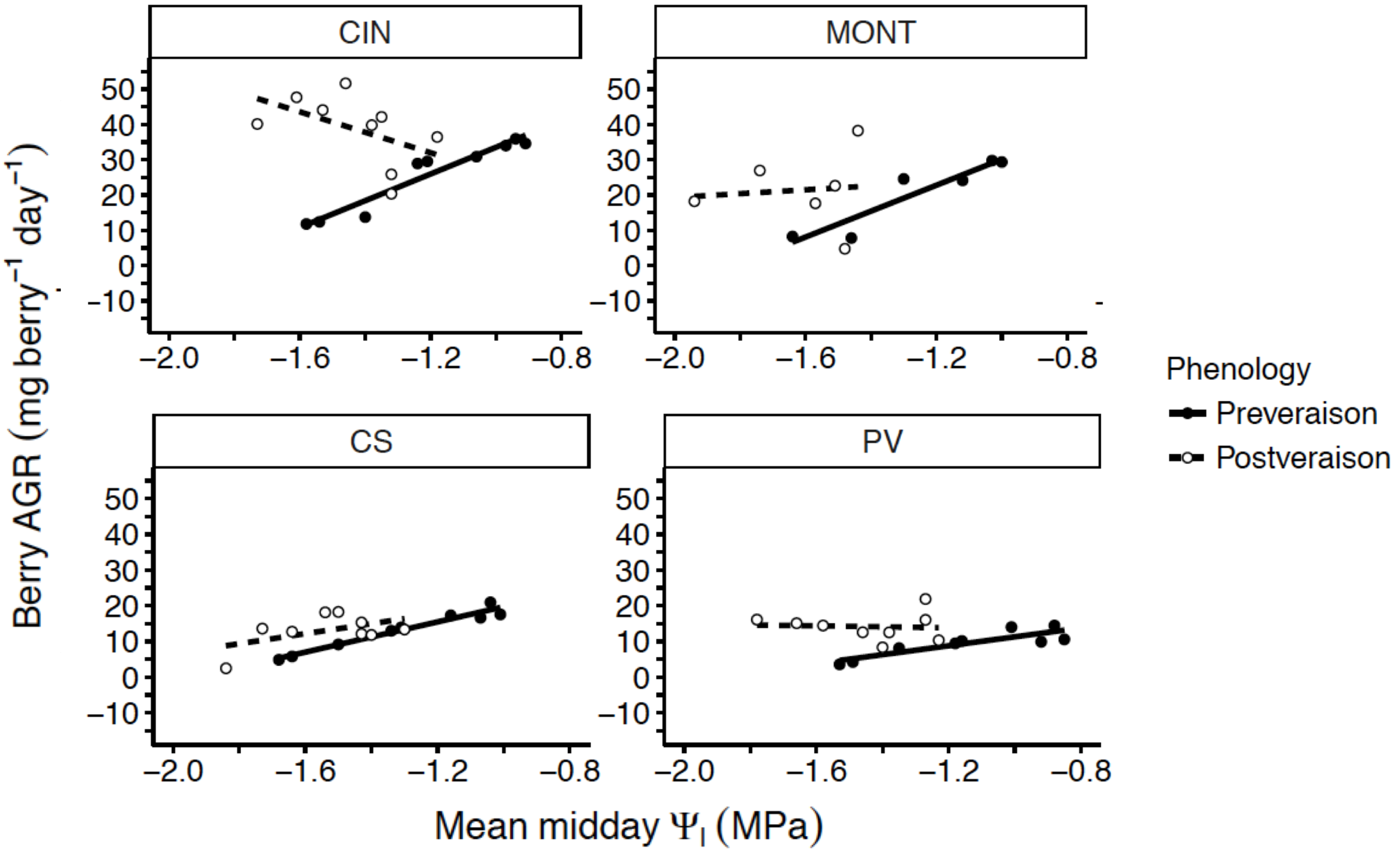


Contraction more sensitive preveraison



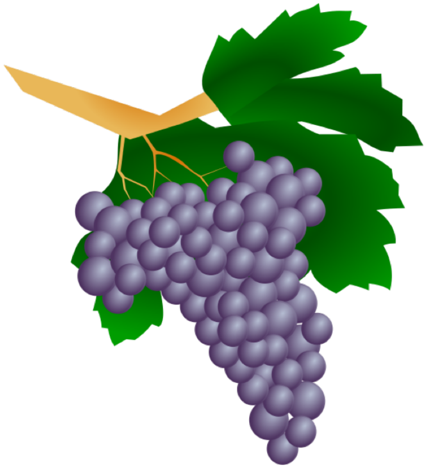
Greenspan, Shackel, Matthews 1995

Growth rate more sensitive preveraison



Alexander Levin, Assistant Professor of Viticulture
Southern Oregon Research and Extension Center and Department of Horticulture
569 Hanley Rd., Central Point, OR 97520
alexander.levin@oregonstate.edu

THANKS A BUNCH!
QUESTIONS?



Oregon State University