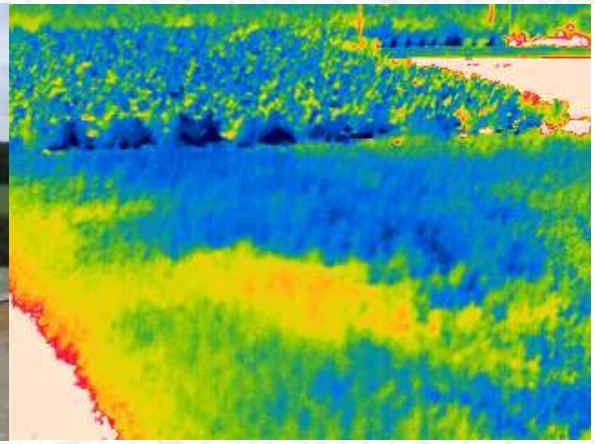
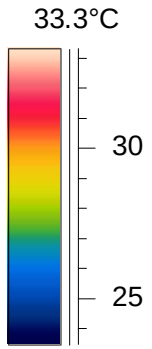
Irrigation research at Lancaster (Ian Dodd)





2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

BBSRC ROPA

HORTLINK I

HORTLINK II

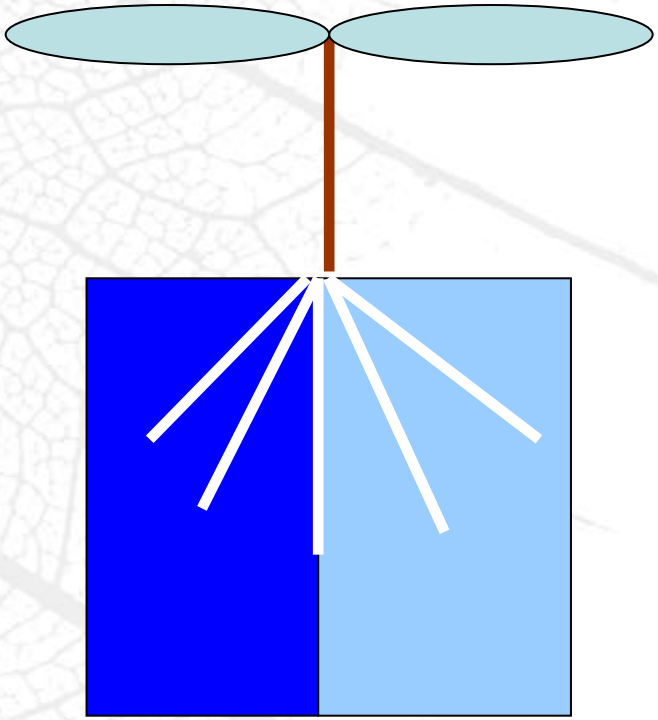
DEFRA – WUE

EU-DROPS

EU-IRRISPLIT

DEFRA PARTIAL ROOTZONE DRYING

EU - SIRRIMED



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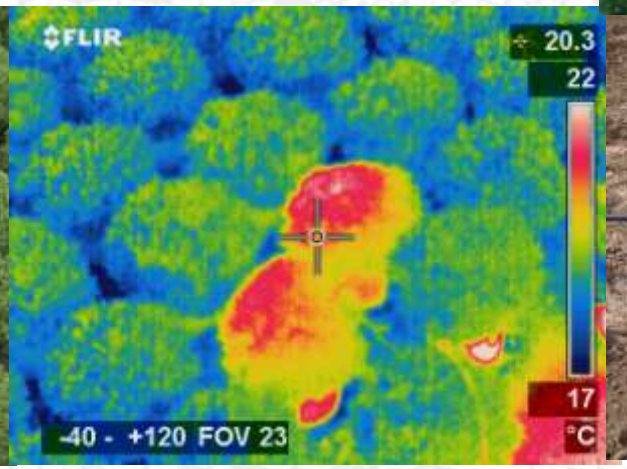
Talk Summary

- DEFRA HH3609STX (PRD) & Signalling
- EU FP7 SIRRIMED
- Plant Growth Promoting Rhizobacteria



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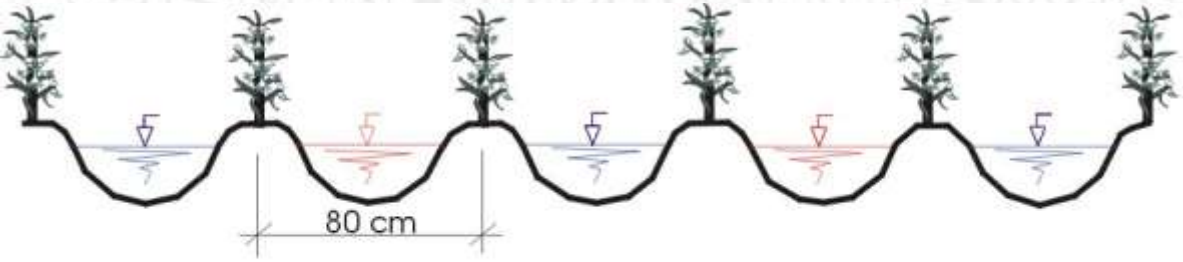
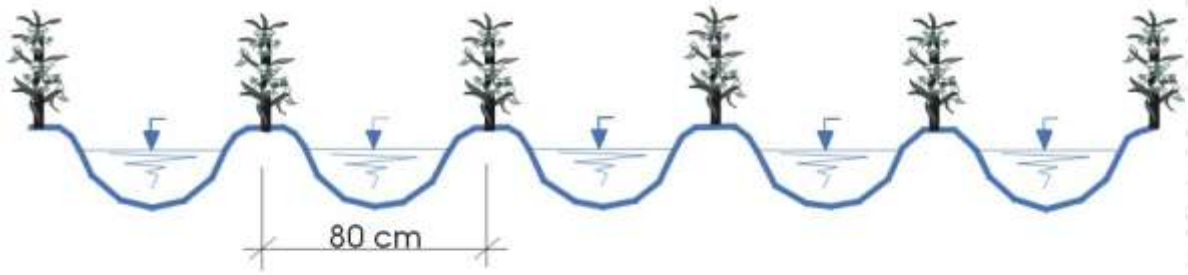
PRD irrigation systems （including furrows / drips）



1. Irr. 2. 1. 2. 1.
3. Irr. 4. 3. 4. 3.

Alternate Furrow Irrigation



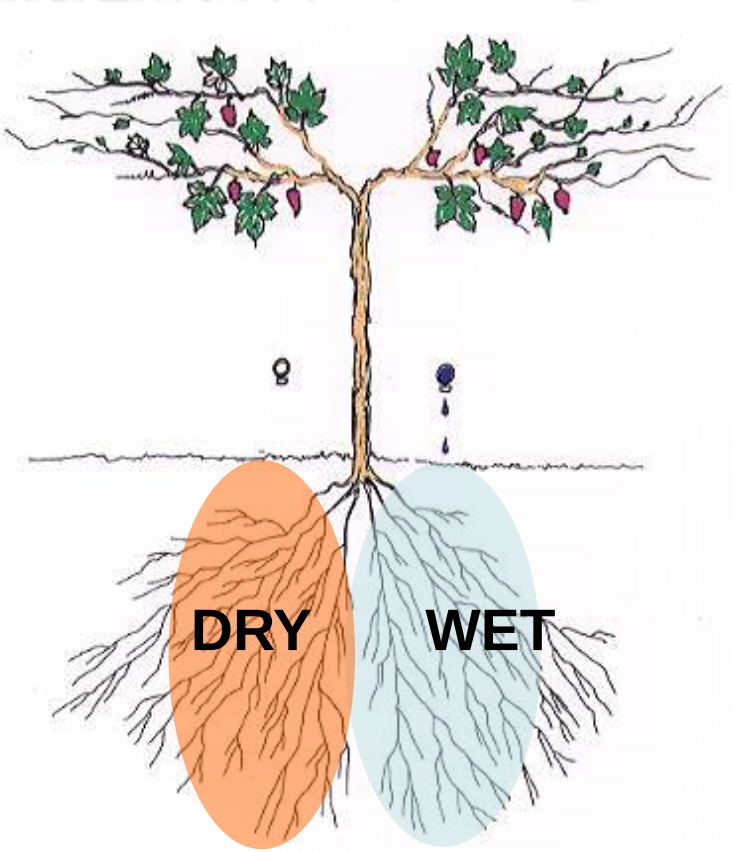
1. Irr. 2. 1. 2. 1.
3. Irr. 4. 3. 4. 3.

Conventionel Furrow Irrigation

Early field data from PRD in grapevine

Dry, Loveys, Botting, During 1996 *Proc. 9th Aust. Wine Ind. Tech. Conf.*, 126-131

Parameter	*FULL*	*PRD*	*% change*
Irrigation (ML / ha)	**0.92**	**0.56**	**-39%**
Fruit weight (kg / vine)	**4.73**	**4.88**	**+3%**
Pruning weight (kg / vine)	**4.62**	**3.47**	**-25%**
Leaf Area (m^2 / vine)	**9.2**	**5.5**	**-41%**
g_s (mmol m^{-2} s^{-1})	**280**	**150**	**-29%**



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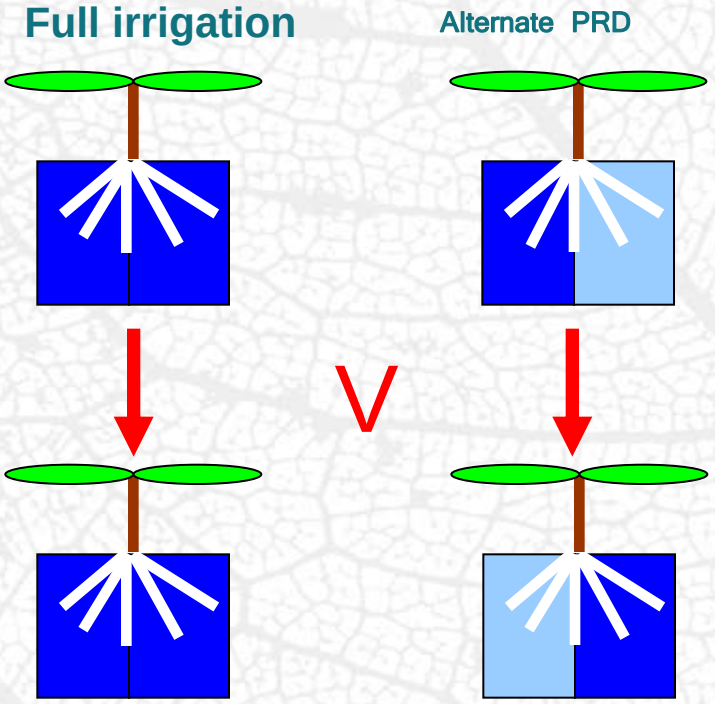
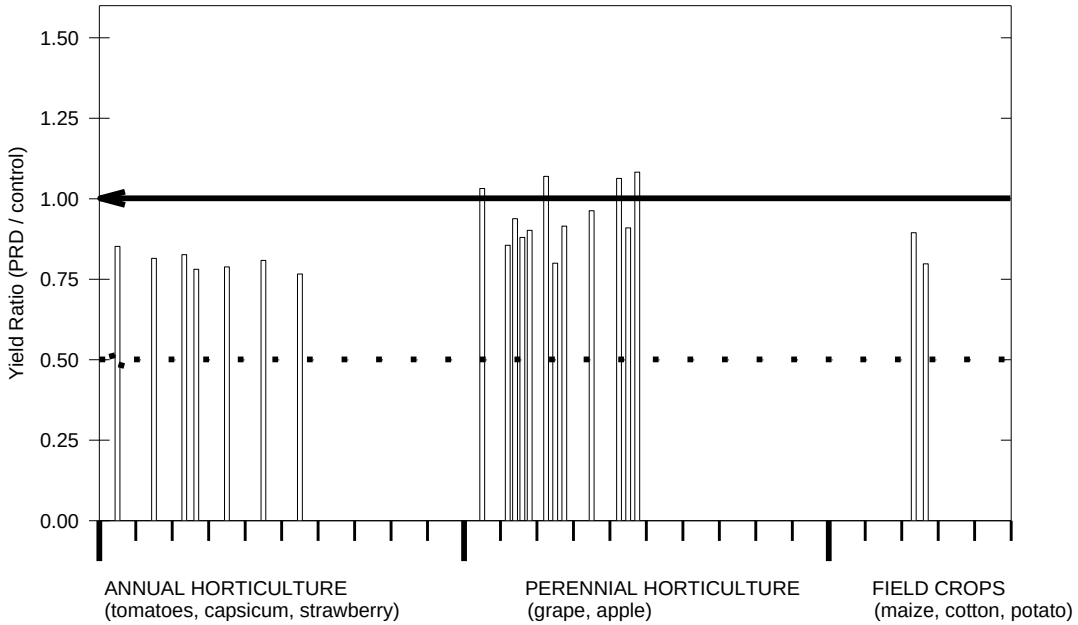
A snapshot of > 200 studies

Yield reductions < 25% despite 50% less irrigation





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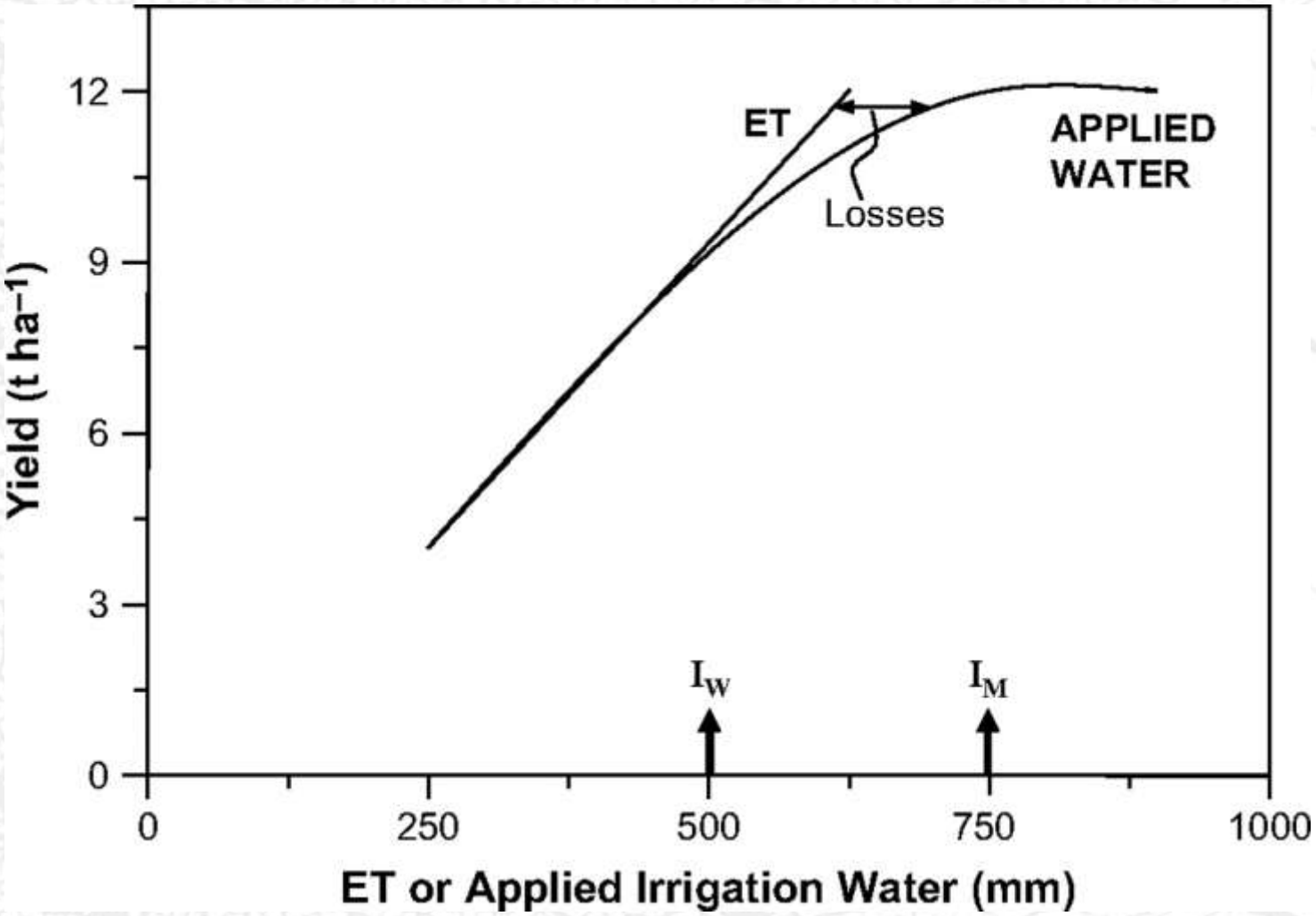
Deficit irrigation to maximise water use efficiency

Fereres and Soriano 2007 *Journal of Experimental Botany* 58, 147-159



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Partial rootzone drying (PRD):
delivering water saving with sustained high quality yield into UK horticulture
Defra Open Contract HH3609STX

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emr
east malling research

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defra
Department for Environment Food and Rural Affairs

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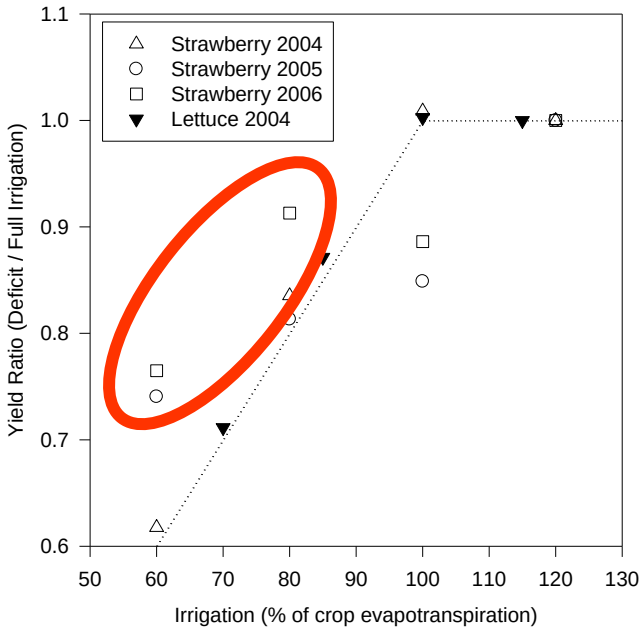
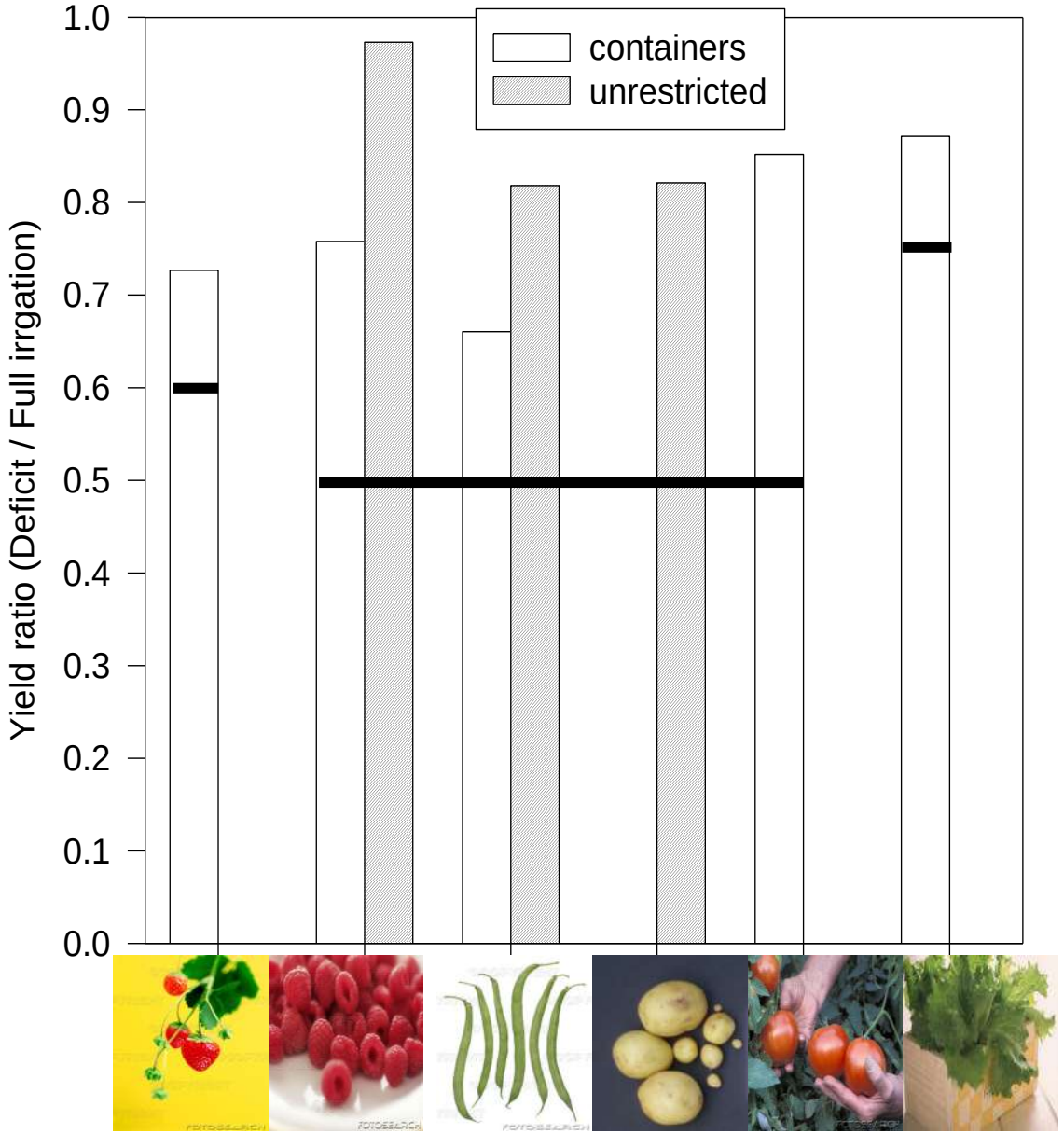
Generally, less water = less yield but not strictly in proportion





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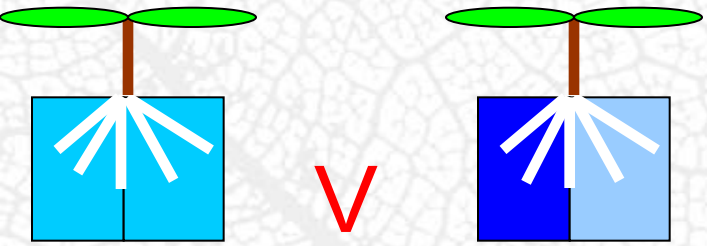
Deficit irrigation : manipulating signalling to restrict water use

How to operate partial rootzone drying effectively ?

WATER

SIGNALS (eg. ABA)

Deficit irrigation (DI) **PRD**



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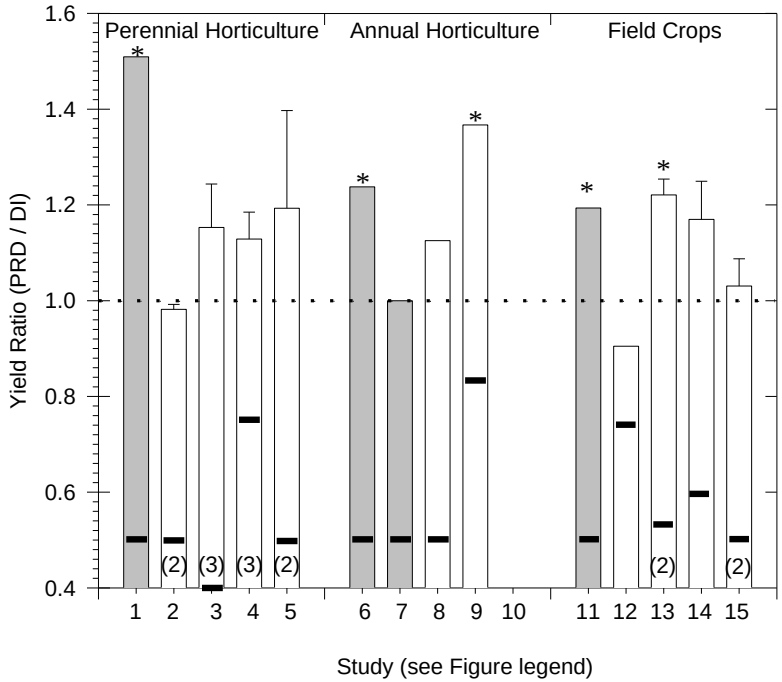

Dodd 2009, *J. Exp. Bot.* 60, 2454-2459

PRD decreased xylem ABA concentration compared to DI

Dodd 2007 *Functional Plant Biology* 34, 439-48

	θ_{pot} (g g^{-1})		θ_{dry} (g g^{-1})		θ_{wet} (g g^{-1})		Ψ_{leaf} (MPa)		[X-ABA] (nM)	
DI	0.26	0.01	0.27	0.02	0.27	0.02	-0.70	0.04	350	45
PRD-F	0.27	0.01	0.23	0.02	0.29	0.02	-0.75	0.06	235	24
P Values	0.36		0.33		0.47		0.47		0.04	

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How to account for different effects of PRD and DI ?

Transpiration

Leaf water potential

Root water potential

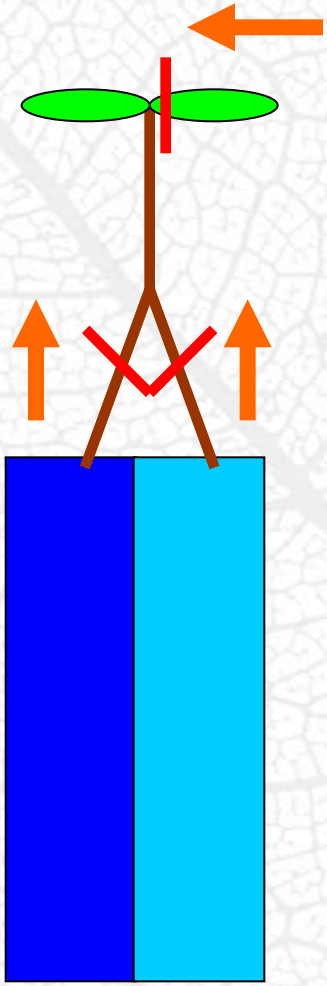
Soil moisture

Total sap flux (J_{total})

Wet (J_{wet}) and dry (J_{dry}) side sap flux

Leaf xylem sap [ABA]

Wet and dry side root xylem [ABA]



INSPIRATION ?

Parliament House

Canberra, Australia

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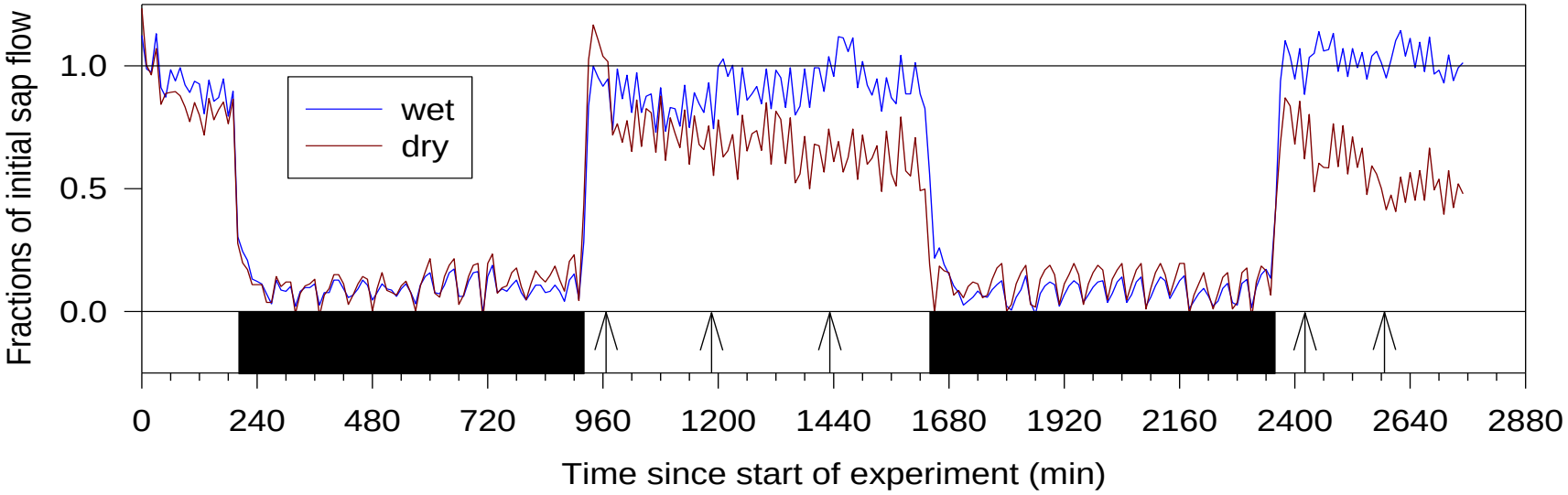
PRD decreases sap flow from roots in drying soil

Dodd et al. 2008a
***Plant, Cell and Environment* 31, 1263-74**



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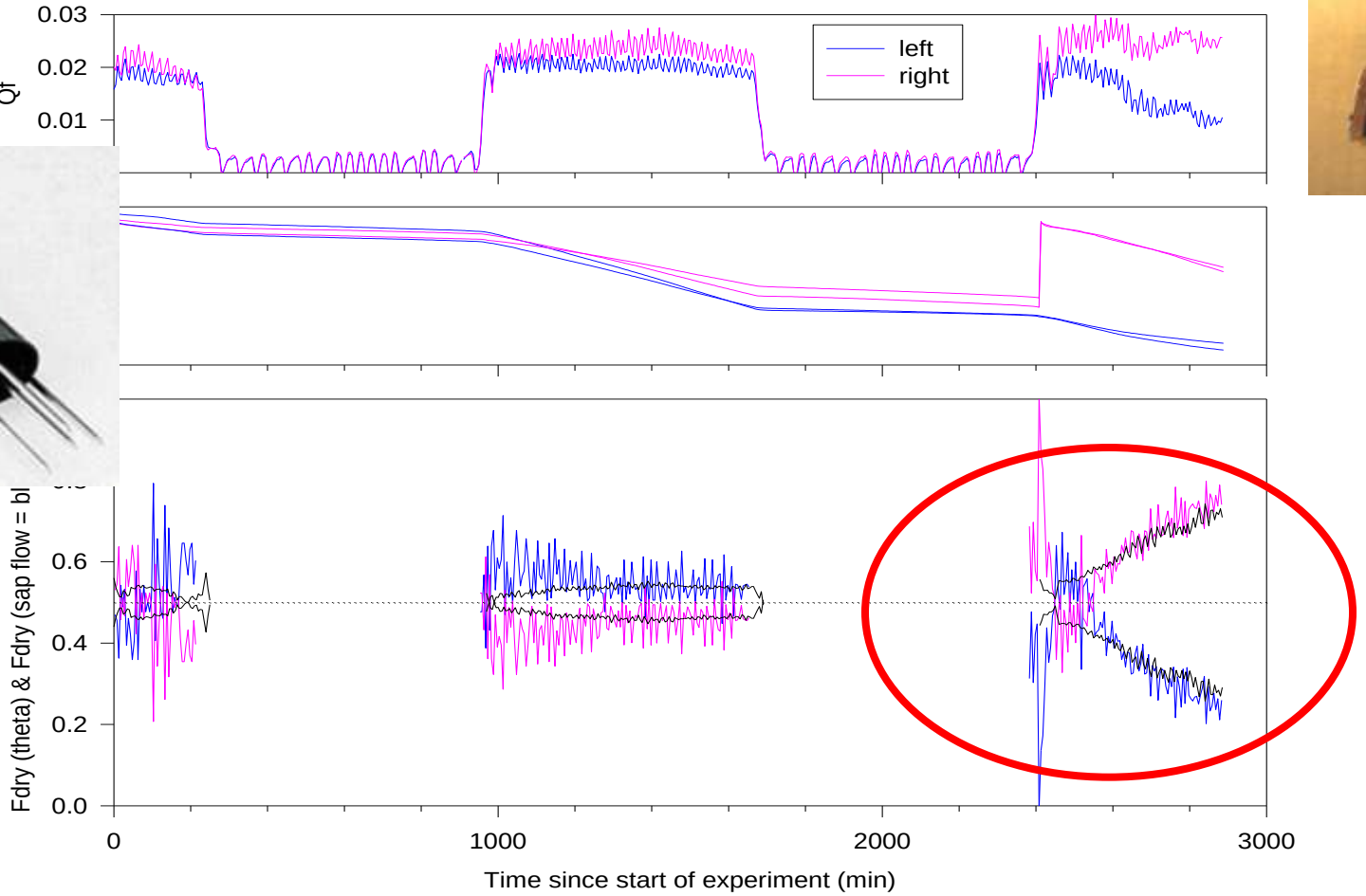
Similar fractions : soil water depletion & sap flow

Dodd, Egea, Davies 2009 *Acta Horticulturae* in press



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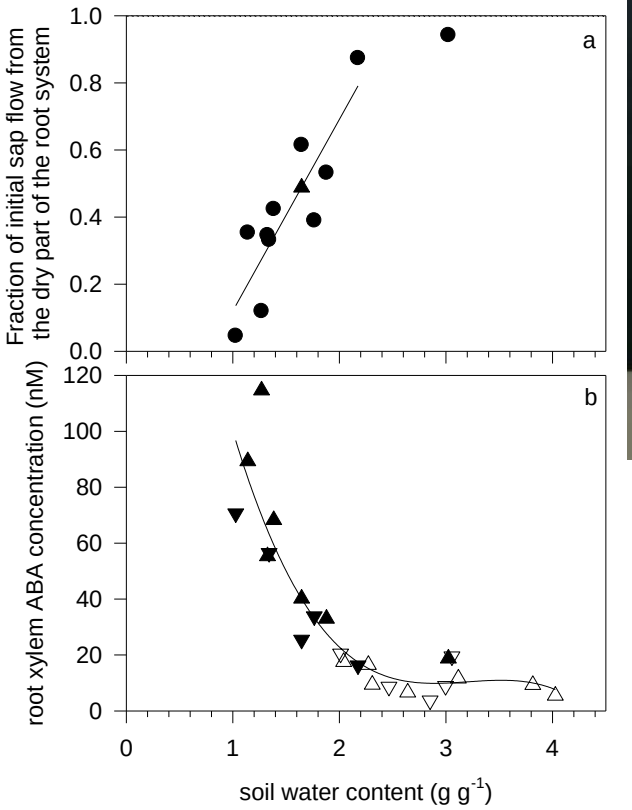
PRD decreases sap flow from roots in drying soil

AND

Root xylem ABA concentration increases

BUT

Compensatory water uptake from irrigated roots



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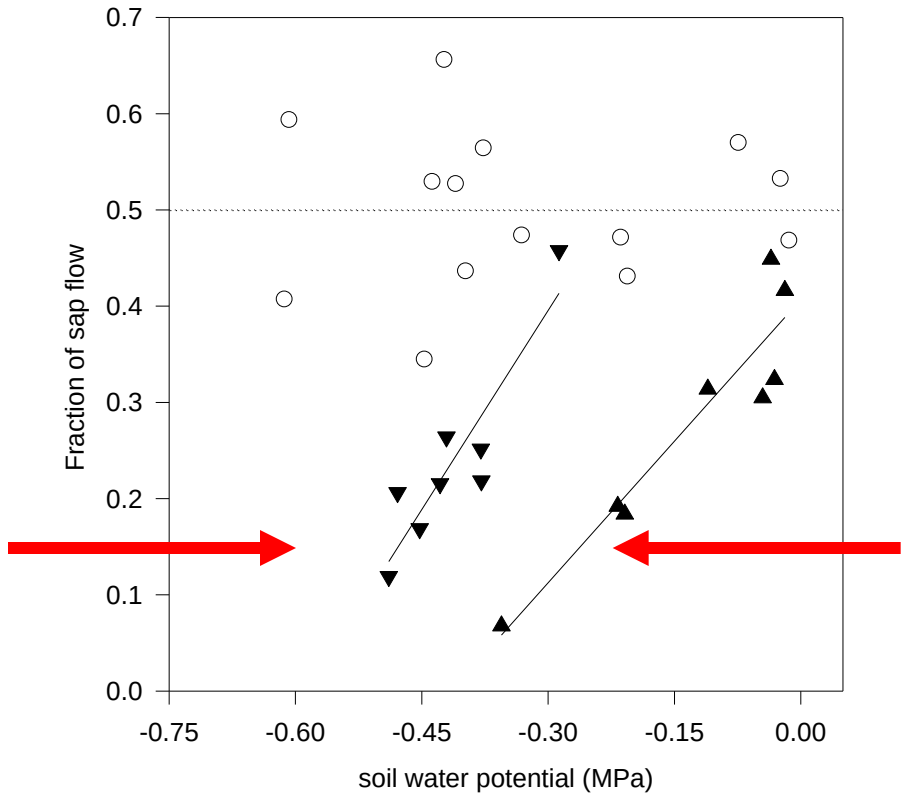
Variation in the sap flow *v* soil water status relationship I.

Soil water status of the wet side

Dodd et al 2008b *Journal of Experimental Botany* 59, 4083-93



Ψwet = -0.09 MPa

Ψwet = -0.01 MPa

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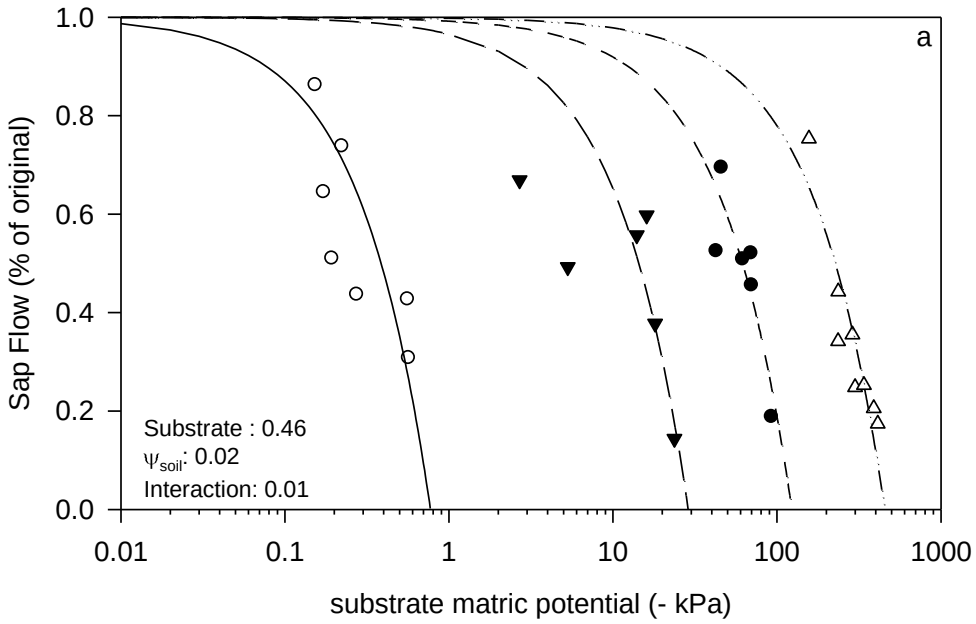
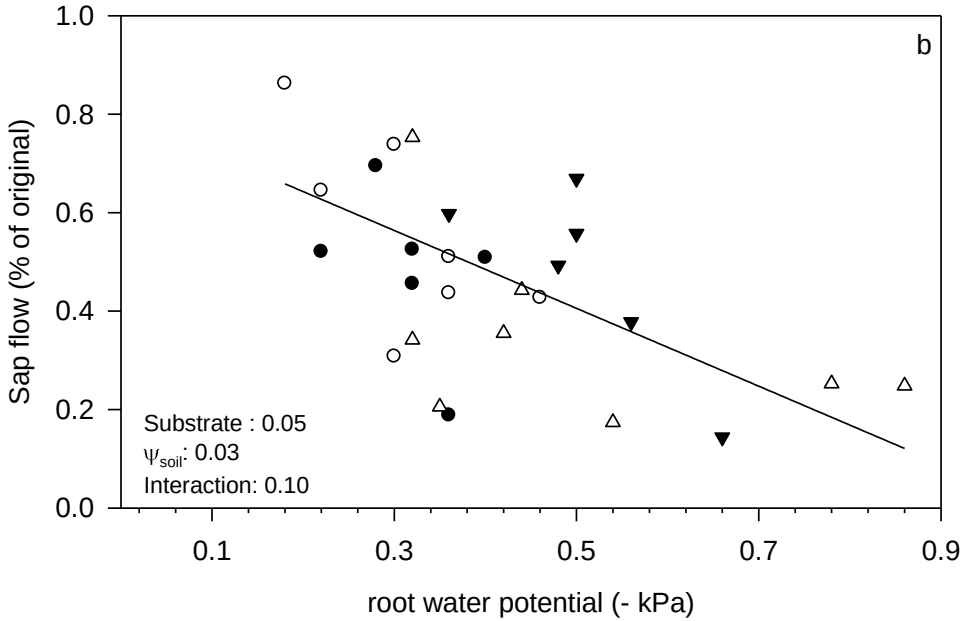
Variation in the sap flow *v* soil water status relationship II.

Substrate effects ? Dodd et al *Journal of Experimental Botany* submitted





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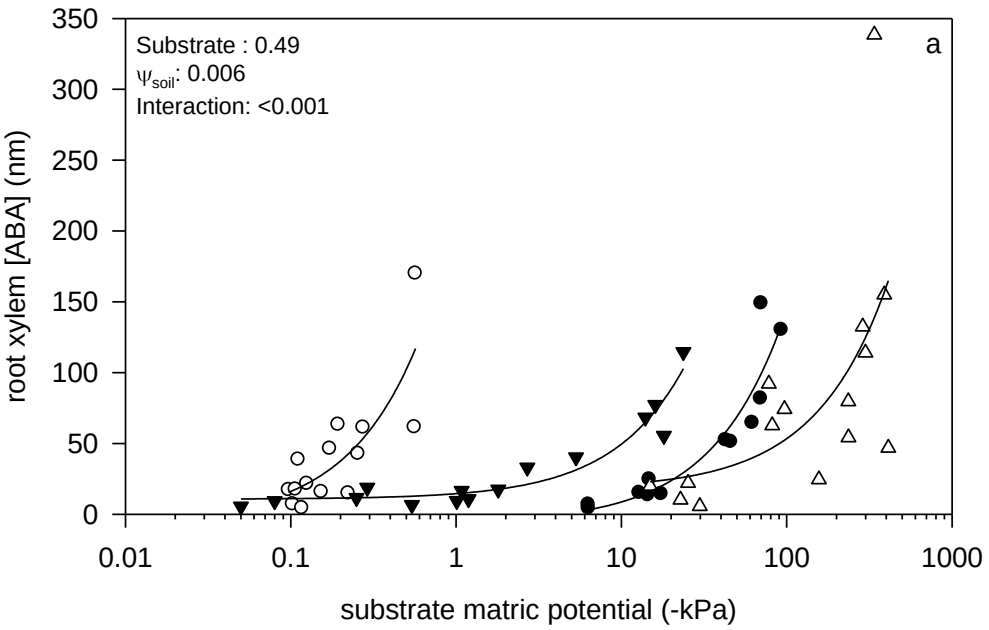
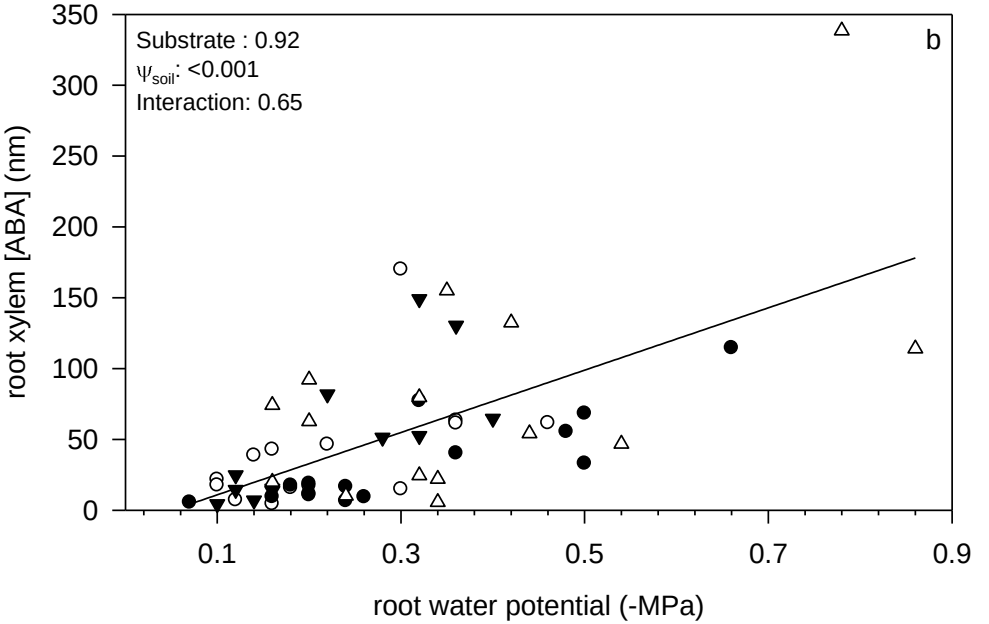
Variation in the [ABA] versus soil water status relationship

Substrate effects Dodd et al. *Journal of Experimental Botany* submitted





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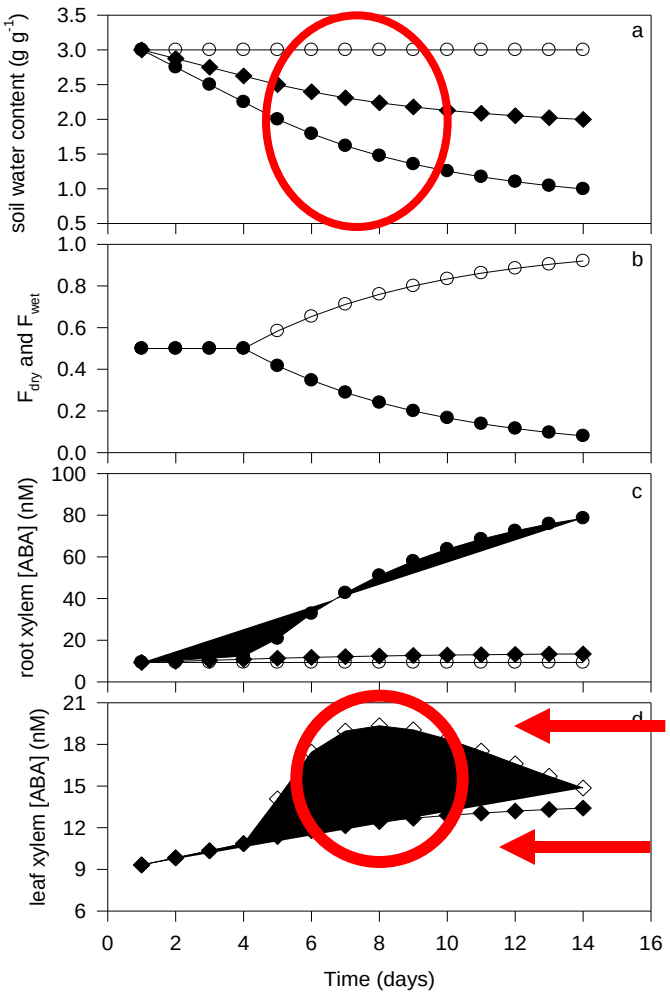
Modelling leaf xylem [ABA] during DI and PRD

Dodd et al. 2008 *Plant, Cell and Environment* 31, 1263-74



WET

DI

DRY

WET

DRY

PRD where [X-ABA] = $X_{dry} F_{dry} + X_{wet} F_{wet}$

DI where [X-ABA] = mean of two sides

HOW TO STAY IN THIS ZONE ?

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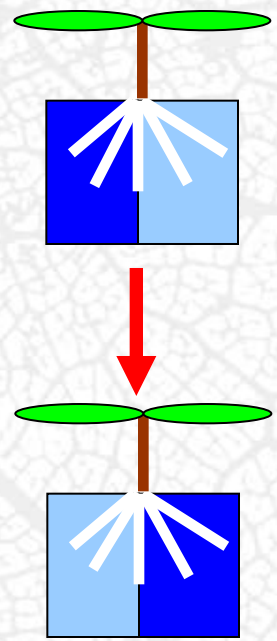
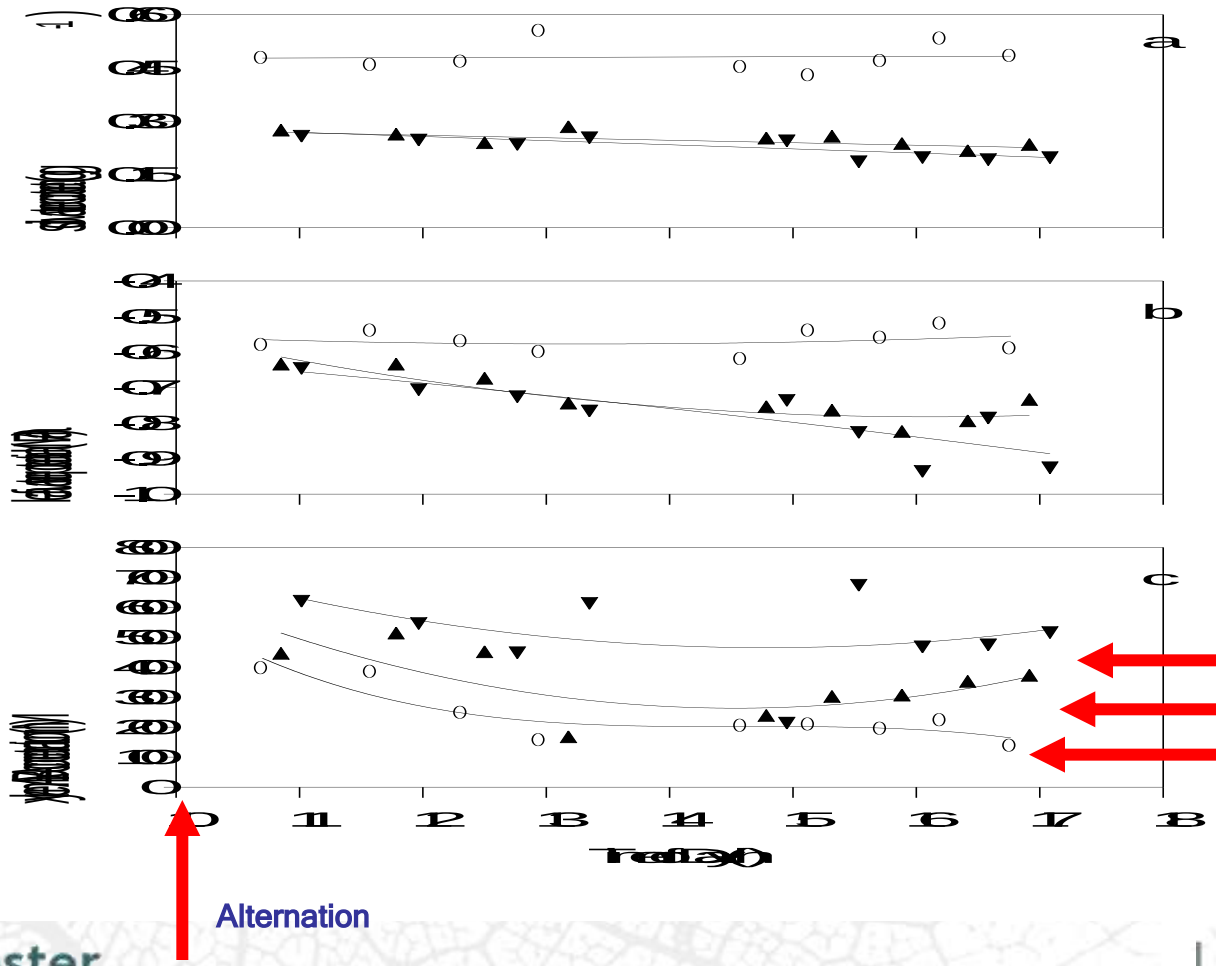
Staying in the "PRD signalling zone" I.

Alternation of wet and dry sides increases root export of ABA

Dodd et al. 2006 *Functional Plant Biology* 33, 1081-89

Alternate PRD





Same θ

Same Ψ

Different [ABA]

PRD-A

PRD-F

WW

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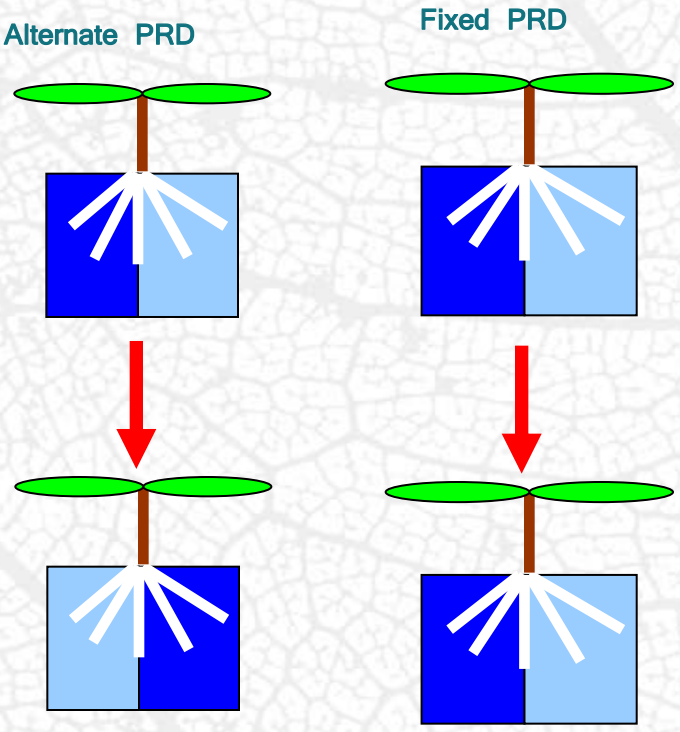
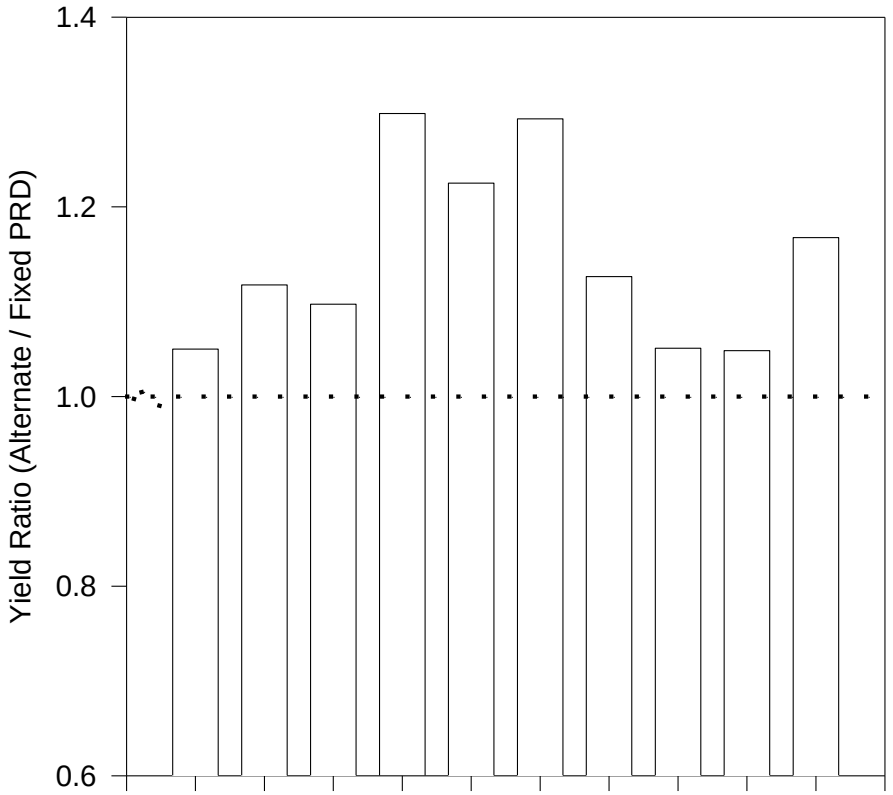
Meta-analysis of fixed v alternate PRD





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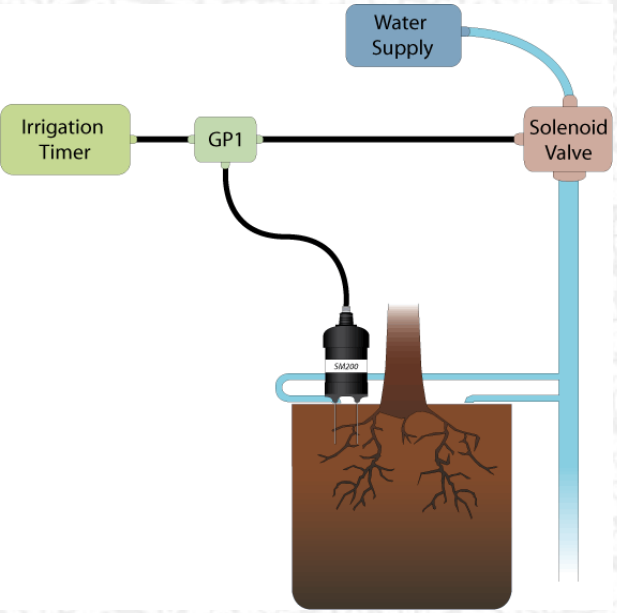
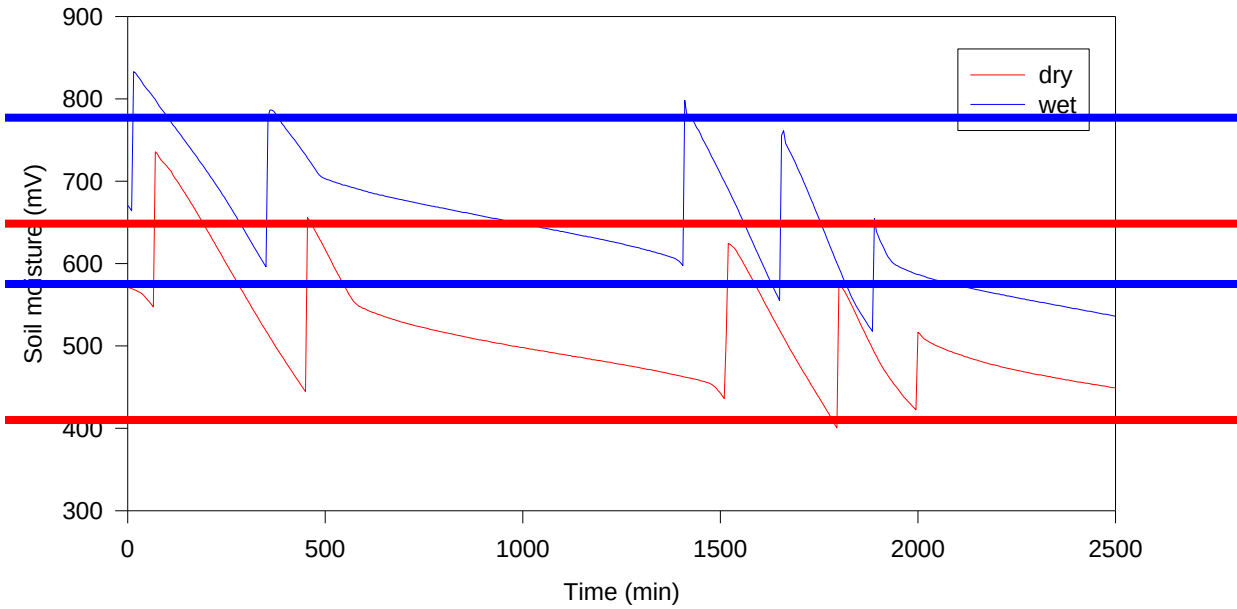
Staying in the "PRD signalling zone" II.

Maintain soil moisture levels at optimum for signalling





a

c

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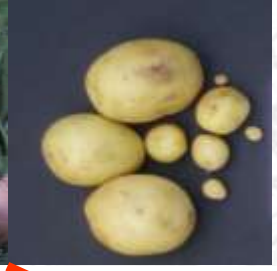
EU FP7 project SIRRIMED




ENGLAND

NETHERLAND

FRANCE - Crau Plain (Rhône Delta)

ITALY - Canale Emiliano-Romagnolo

SPAIN
Segura & Guadalquivir Basin

GREECE - Karla Basin

LEBANON - Litani Basin

MOROCCO
Guerdan Region
(Souss Valley of Morocco)

EGYPT - Noubaria Region

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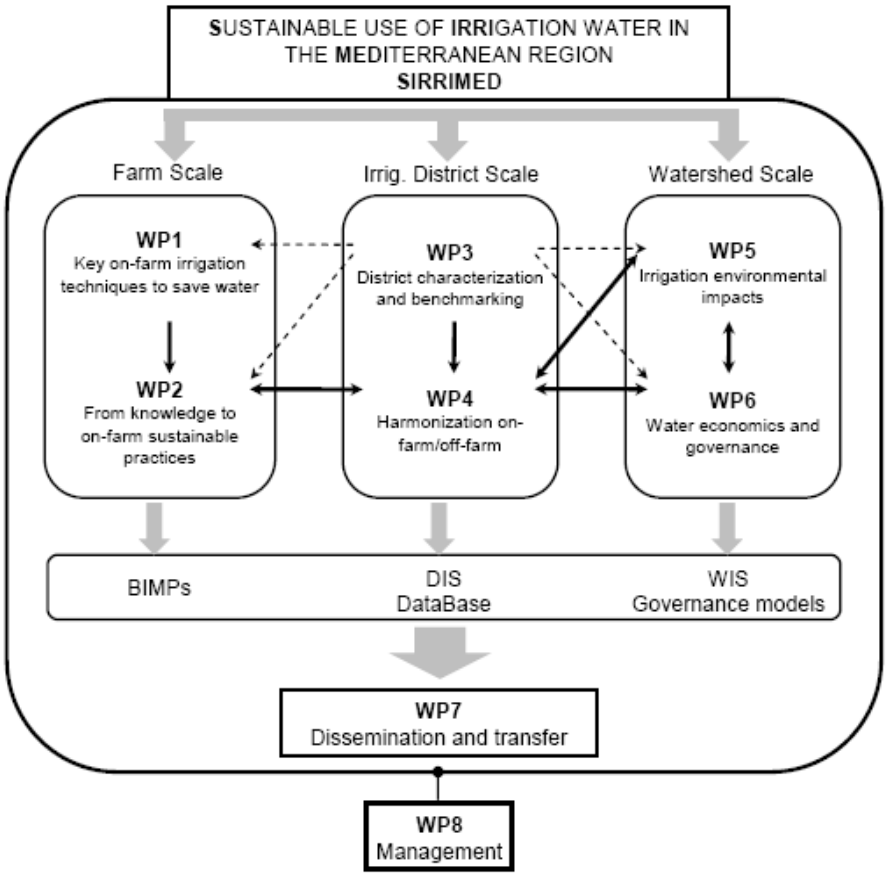
Graphical presentation of the components showing their interdependencies



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WP 1 within SIRRIMED

Precise Irrigation Scheduling

Physiology under Deficit Irrigation

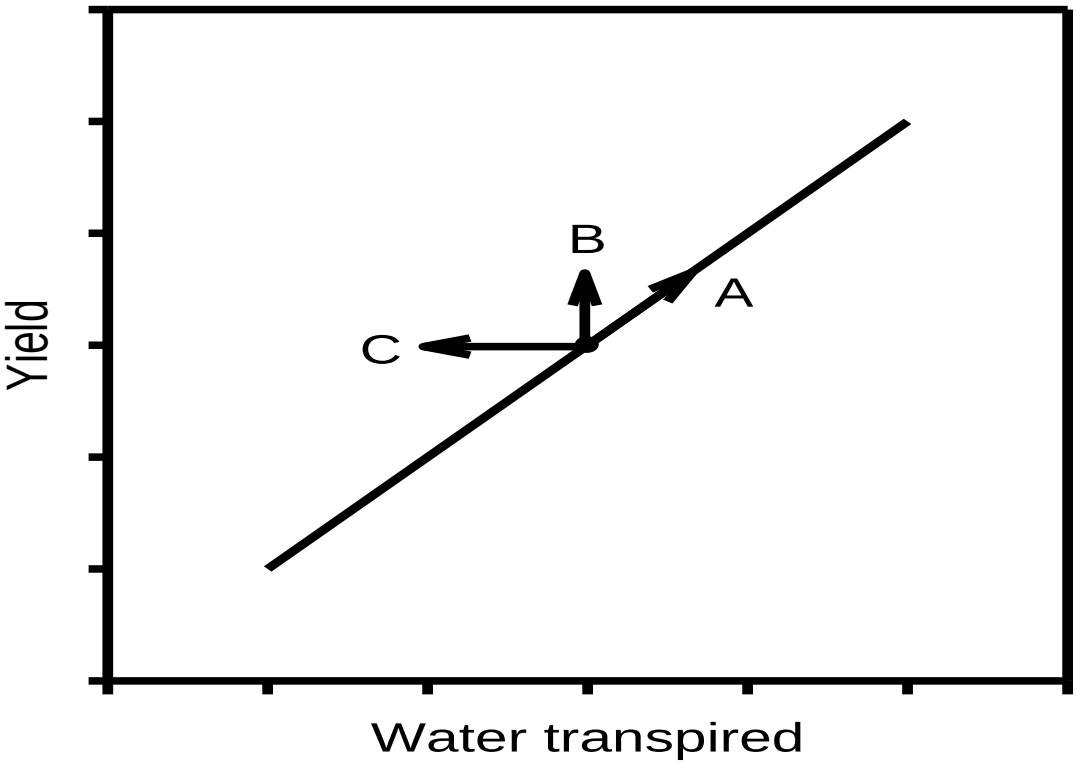
Using Poor Quality Water

Greenhouse Water Saving

Agronomic means to improve crop yield （after Passioura 1977）

Increase Harvest Index

Increase water use efficiency



Use more water

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Acknowledgements

The Lancaster team

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Rosalia Teijeiro

Collaborators

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