Kevin Foster
School of Plant Biology
Faculty of Natural and Agricultural Sciences

Kevin holds a Bachelor of Science degree from Curtin University and a Diploma in Agricultural Technology.

He is currently on study leave from the Department Agriculture and Food WA where he has worked on a wide variety of research projects on pasture improvement for over 20 years.

In his PhD, Kevin researches the drought resistance mechanisms of a new perennial herbaceous pasture legume with the common name ‘tedera’.

Kevin’s study is among the first in the world to investigate the physiological mechanisms in the field that confer drought tolerance in tederas.

(This is an abbreviated version of his research. For more information contact Kevin by e-mail kfoster@agric.wa.gov.au)
Mechanisms of drought tolerance of albo tedera (Bituminaria bituminosa var. albomarginata)

Kevin Foster, Professor Hans Lambers, Dr Megan Ryan and Dr Daniel Real
Bituminaria bituminosa var. albomarginata (tedera)

- Has clearly evolved mechanisms to withstand severe drought
- Is a highly-light adapted plant
- Can tolerate drought stress at germination and the seedling stage
- Utilises a wide range of physiological & morphological mechanisms
  - that confer drought tolerance
  - and high water-use efficiency
- Has a high degree of stomatal control
- Very low critical relative water content in leaves
- Exhibits some of the lowest leaf water potentials for agricultural plants
- All these mechanisms combined allow this plant not only to survive over summer but to be productive for our system
Its native environment

- Lanzarote, and coastal semi arid habitats
- volcanic in origin
- 150-200 mm rainfall and is highly seasonal
- rain tends not to be heavy
- high interannual variability
- high amount of both irradiance and summer temperatures
Canary islands
The plant

- self-pollinated (but low levels of outcrossing can occur)
- perennial herbaceous legume
- minimal leaf drop during summer
- prostrate to erect growth habit
- high leaf/shoot ratio
- woody basal stems
- good seed retention
- drought tolerant
Cut and carry of tedera in the Canary Islands

How does tedera survive the spring / summer drought and yet still be productive?

(Photos by Pilar Mendez)
The presence of a range of mechanism such as leaf movements, stomatal control, osmotic adjustment and root structure, all contribute to the drought resistance of tedera.
Where did we undertake our research?

Field
- 2 sites
- contrasting soil types
- Medium-high rainfall in the wheatbelt
- Newdegate and Merredin
- Controlled small plot
Newdegate experiment Jan 09

82% of light transmitted

Tr 2 irrigated
Tr 1 non-irrigated
Tr 3 rainfed

Shelter cover removed in winter
Large pot experiments on mature plants
(Soil reconstructed from the field)
What we measured or examined

- Leaf folding angle
- DM yields
- Plant water use and rooting depth (NMM)
- Relative leaf water content (tissue water status)
- Leaf water potential
- Osmotic adjustment
- Net photosynthesis, stomatal conductance
- Leaf and stem microscopy
Confirmation of the drought tolerance of tredera in the field

Newdegate
Feb 2009

Relative Water Content

# 4 lucerne # 6 # 9 # 11 # 12 # 13 # 22

tr 2 Pre-irrigated
tr 2 Post-irrigation
tr 3 Rainfed
tr 1 Non-irrigated
Pre-dawn leaf water potential
Merredin Jan 2009

More negative greater stress
Paraheliotropism (leaf folding)

Rapidly induced by unfavourable conditions

Fast-acting stress response

Fully reversible with little cost to the plant

Compensates for lack of heat exchange if stomata are closed

Folded leaves can reduce light by 30 – 40 % compared to horizontal leaves
Tolerance at seedling stage is also highly desirable.
Osmotic adjustment helps *tedera* maintain water volume and leaf turgor.
Increase in root mass ratio.
Change in leaf hairs

drought

control
Leaf rolling and smaller leaves reduces effective leaf area

Lucerne day 15 of drought

Tedera day 45 of drought
Tedera 15 days after re-irrigation
Conclusions

The need to improve drought tolerance in our perennial plants is particularly urgent.

The ability to survive the summer drought determines their persistence and therefore the important autumn yield of our perennial species.

We need an understanding of the mechanisms operating at the whole plant level.

Tedera now opens a door now on what is possible within our new perennial specie.
Summary of results

Tedera has clearly evolved mechanisms to withstand severe drought.

Tedera is a highly-light adapted plant.

Tedera adjusts its morphological & physiological traits to successfully cope with low soil water availability, high temperature & irradiance over summer.

Tedera avoids water deficits by
• maximising water uptake through its tap and lateral roots
• minimising water loss by its excellent stomatal control
• leaf folding to reduce transpiration and the interception of light

The very low levels of leaf water potentials in live leaves and RWC are exceptional for a herbaceous perennial legume species.
Acknowledgements and Funding

FFI CRC

School of Plant Biology, UWA

Department of Agriculture and Food WA

My supervisors, Professor Hans Lambers, Dr Megan Ryan and Dr Daniel Real

John Kuo, Peta Clode and Lyn Kirilak from CMCA

Advice from Neil Turner, Michael Renton, Erik Veneklaas, Tim Colmer, Greg Cawthray and Martin Bader

With support from Mike Ewing and Clinton Revell