Better tree performance and water use efficiency through root system resilience

Everard J. Edwards

Shuang-Xi Zhou, Alex Lawlor, Adelle Semmler & Rob Walker

Australia's National Science Agency

Hort Innovation
Strategic levy investment
ALMOND FUND
ALMOND BOARD OF AUSTRALIA
CSIRO

I would like to begin by acknowledging the Traditional Owners of the land that we're meeting on today, and pay my respect to their Elders past and present.

AL13009: project aims

1. Comparative assessment of the resilience of available *Prunus* rootstocks to abiotic stresses,
   - *develop a rapid screening method (greenhouse).*
2. Optimised management for root systems and rootstocks (irrigation and fertigation),
   - *improved understanding root phenology, function, activity via greenhouse and field experiments*.

Rootstock resilience screen

Growth is the ultimate measure of a plant's performance.

We used *Relative Growth Rate* (RGR = increase in biomass per unit of biomass per day).

Screening is defined by a stress index:

$$Stress\ index = \frac{RGR\ stress}{RGR\ control}$$

Rootstock genotype	Water deficit index (50% ETc)	Soil conductivity index (3.3 dS m^{-1})
Barrier 1 / Empyrean	1.0	1.0
Bright's Hybrid	***0.4***	0.8
Controller 6	1.1	1.0
Controller 7	***0.4***	0.9
Controller 9.5	***0.4***	***0.6***
Cornerstone	***0.5***	0.8
Garnem	***0.4***	0.8
GF677	***0.5***	1.0
Krymsk 86	***0.4***	1.0
Nemaguard	***0.5***	0.6
RootPac 20	***0.4***	0.8

Improved understanding of almond root systems

Examined impact of water and N availability on root growth, location and phenology,

- collaborated with AL14005 on water/N use field experiments,
- also examined whole tree water use.

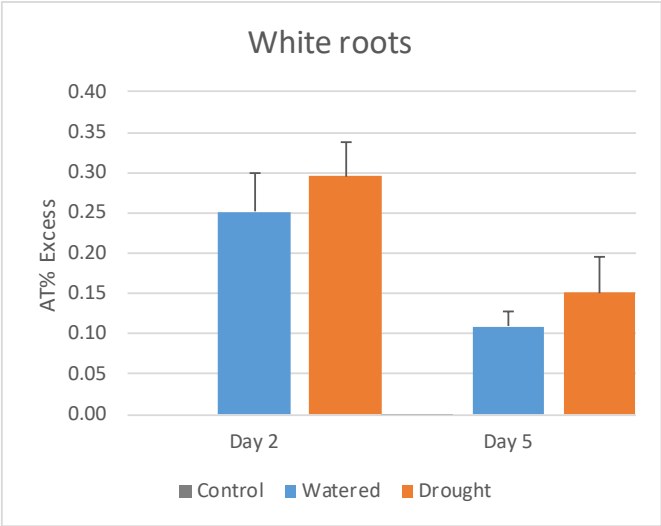
Determined phenology and root age effects on N uptake,

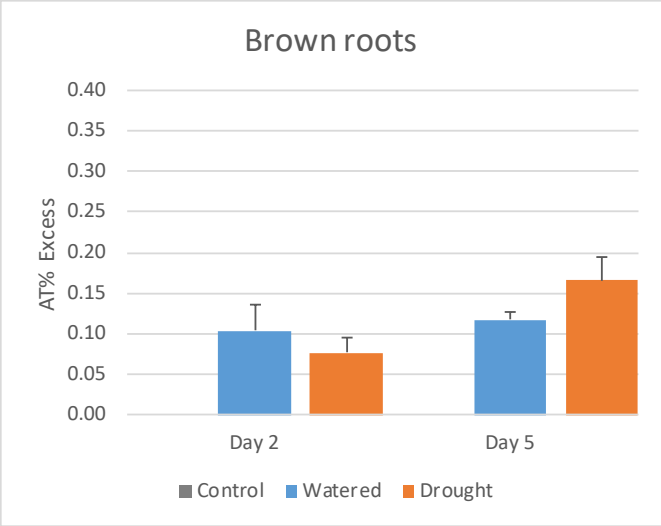
- Greenhouse and field pot experiments using stable N isotope.

Examined rootstock : scion interactions on N uptake and allocation,

- Greenhouse experiments using stable N isotope.

Root age effect on N uptake by fine roots





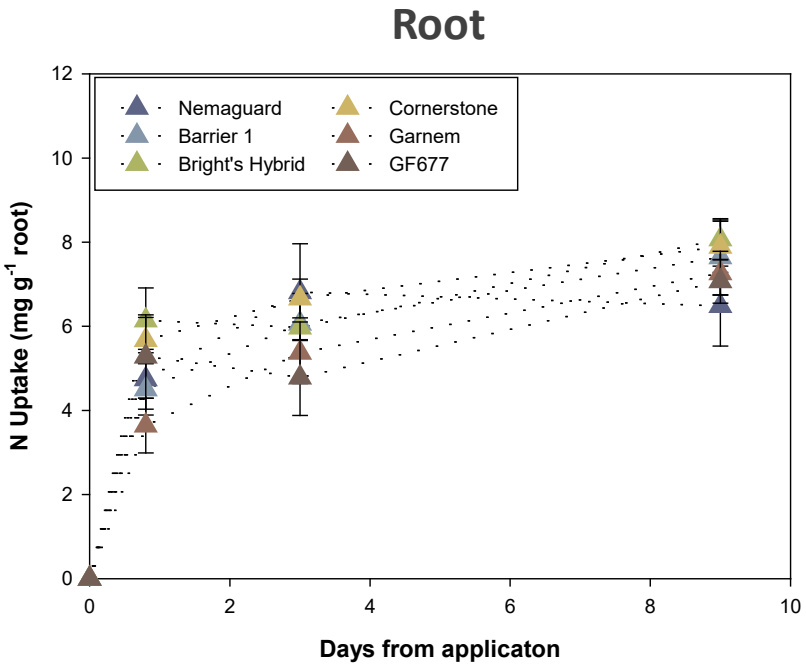
White roots typically < 2 weeks old.

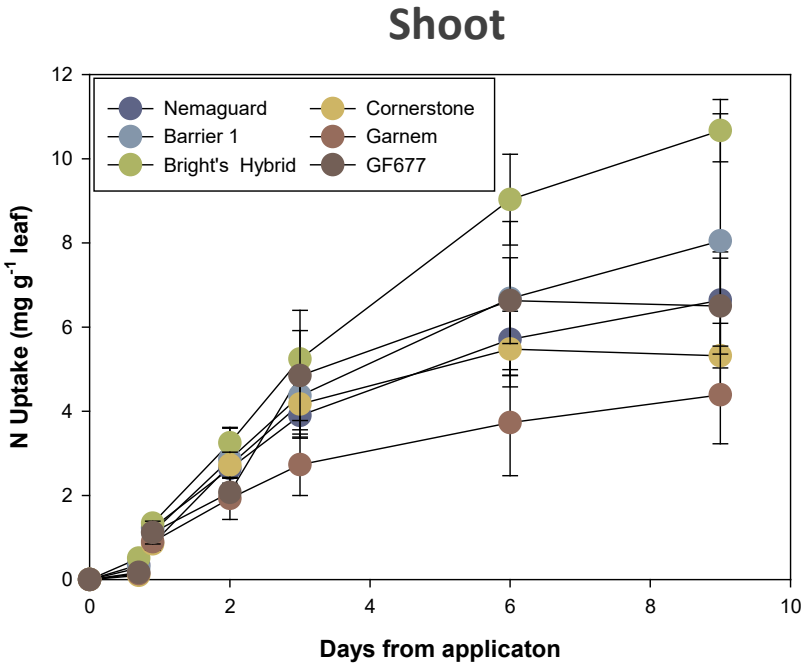
Brown roots still take up N, approx. half rate of white roots.

Note that much greater brown root mass than white root mass in root system.

Nonpareil : Nemaguard - greenhouse.

Rootstock affects rate of N transport to shoot





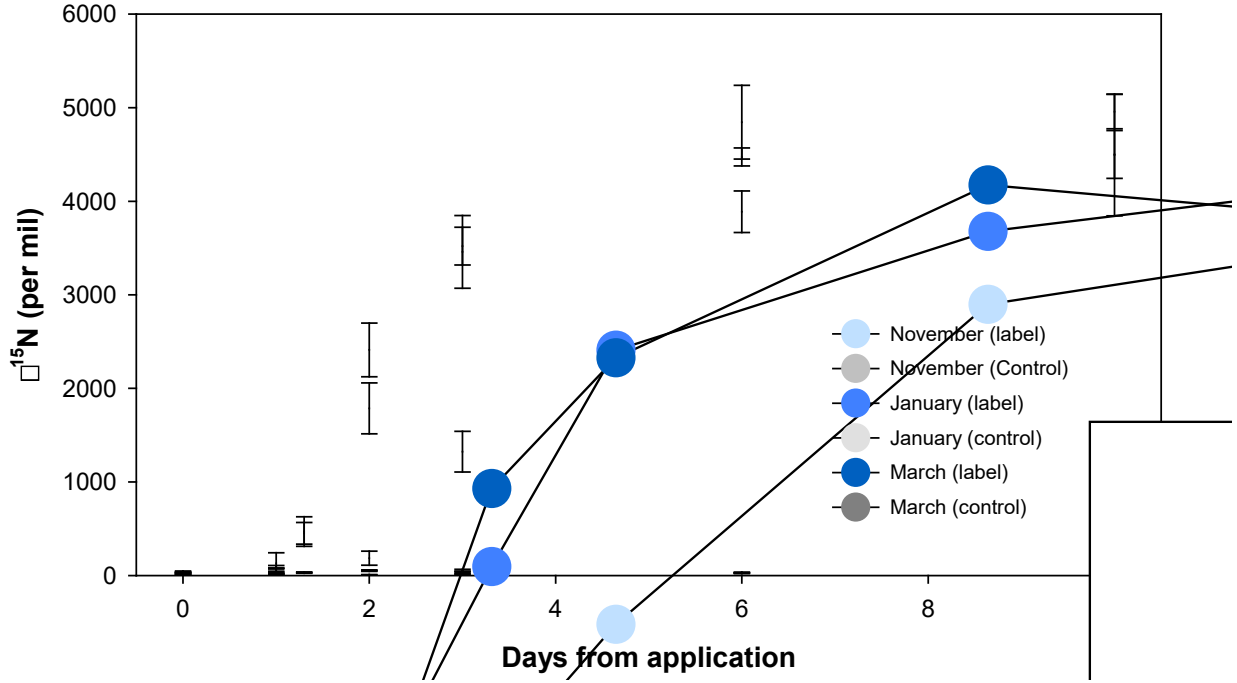
Rapid root uptake of N.

Accumulation in shoot slower.

Nonpareil : various stocks - greenhouse.

Roots will take up N throughout season

N accumulation in leaves

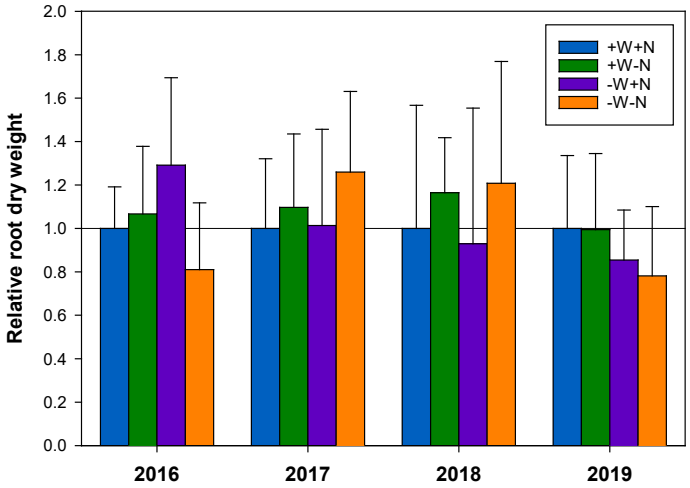


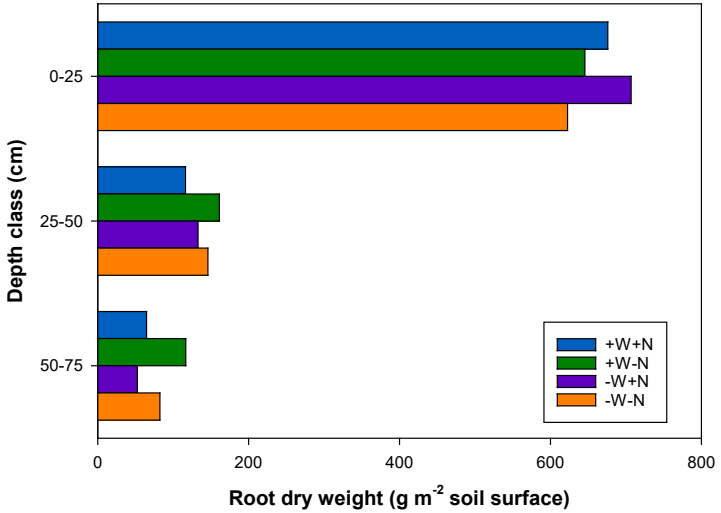
Canopy still present in March, cooler than November.

Uptake slower in November, but active growth period.

Nonpareil : Nemaguard – field (200L pots).

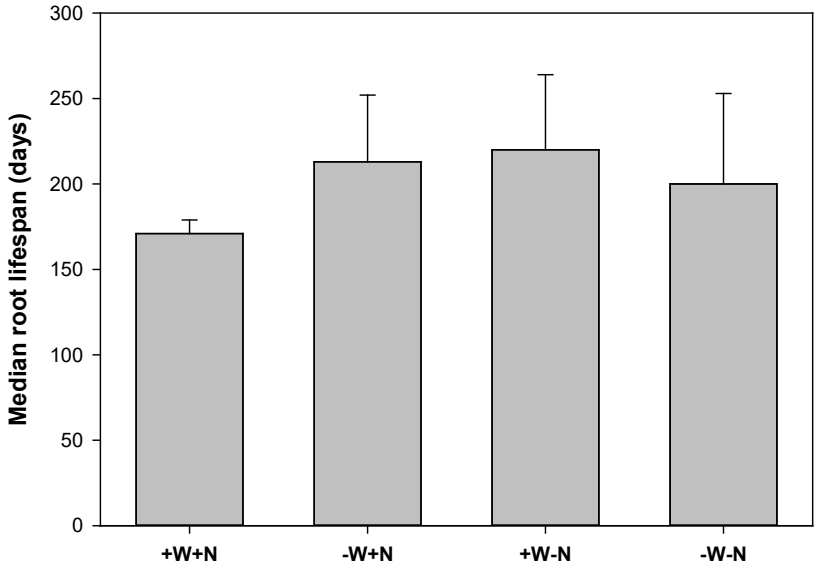
Reduced inputs affect position but not amount of fine root





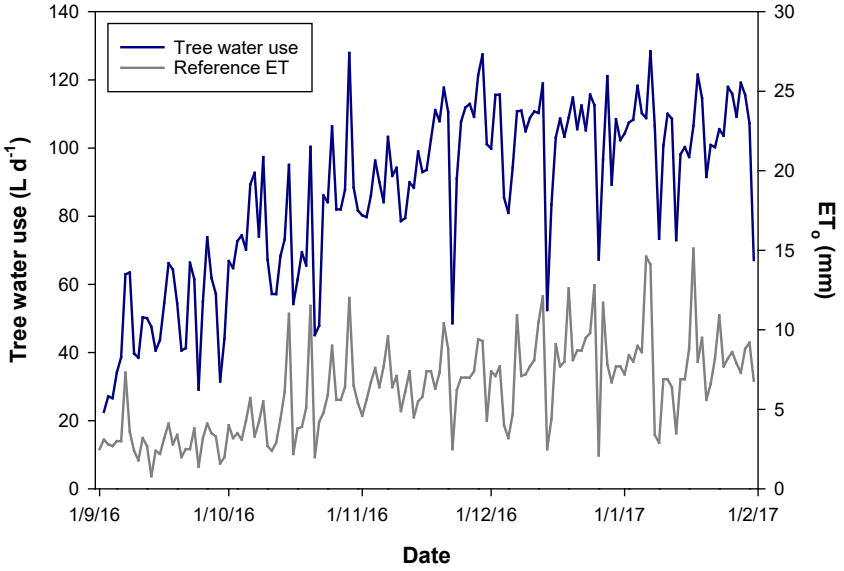
Data from Ag Vic field site, winter coring.

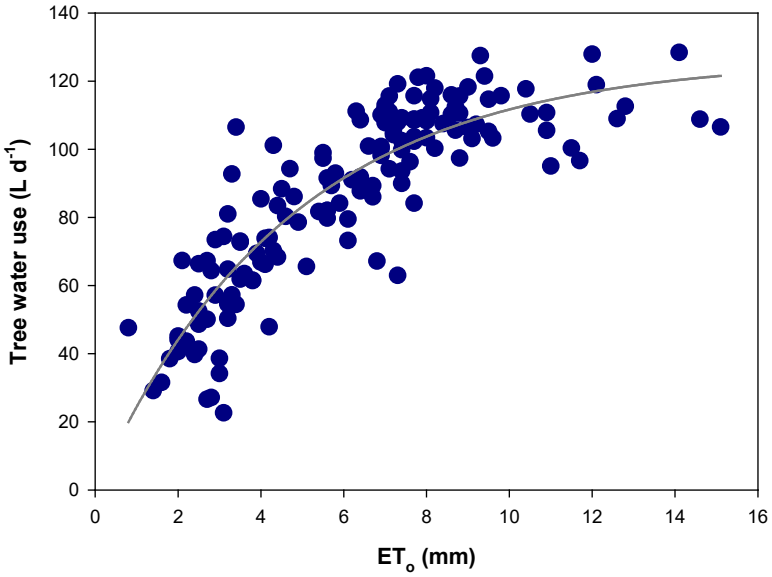
Fine roots live for a full growing season



Data from Ag Vic field site, minirhizotrons..

Atmospheric demand drives tree water use

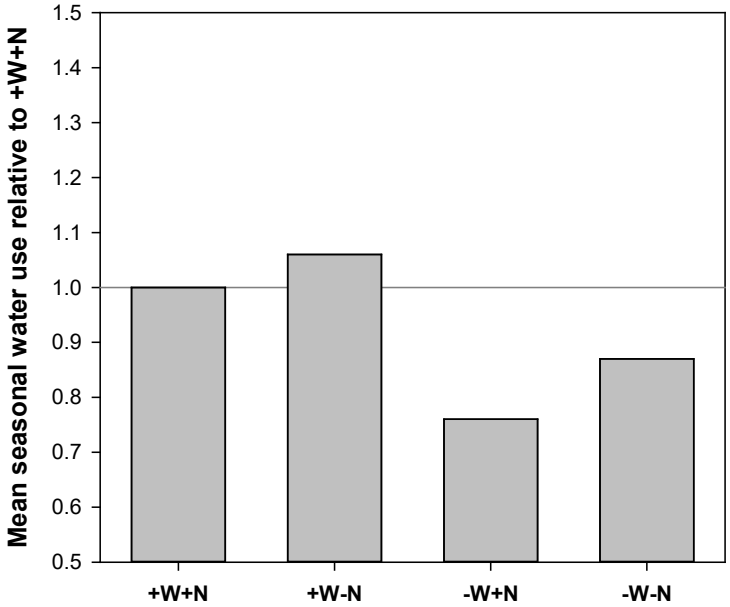




…for a given tree size, once canopy established.

Data from Ag Vic field site, sapflow.

Tree water use correlates with canopy size



Reduction in water use less than reduction in irrigation (suggests >irrigation use efficiency).

Data from Ag Vic field site, sapflow.

Summary

Rootstock resilience:

- most rootstocks have good salinity tolerance,
- Barrier 1 & Controller 6 tolerated water deficit (needs field testing).

Direct measurements of tree water use, supported observations of improved yield/unit irrigation water with reduced water inputs.

Reduced water and/or N inputs had little effect on fine root growth, but increased root depth explored.

Older fine roots able to take up significant amounts N.

Indication that rootstock genotype can affect N allocation.

Implications for management

Scope to explore increased input use efficiencies – need to look at multiple seasons.

If active canopy, root systems will take up N addition.

Exploring a greater range of rootstocks and matching to scions may provide improved production .

Acknowledgements

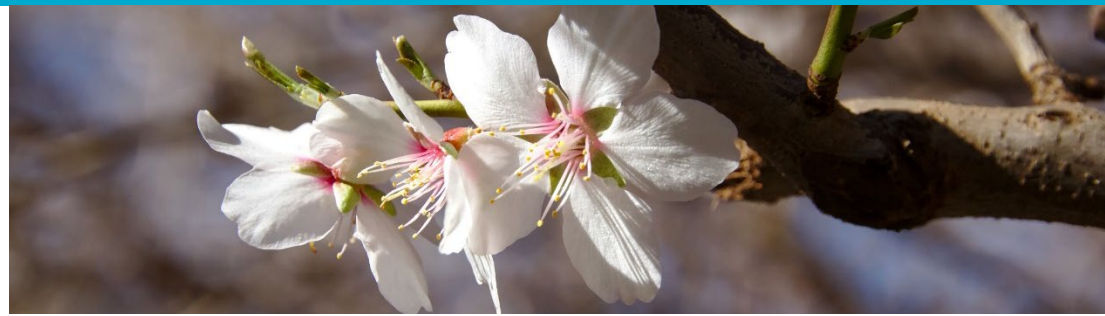
- Annette Boettcher
- Bronwyn Smithies
- Damien Mowatt
- Nina Welti
- Steve Svaras
- Lynne MacDonald

CMV FARMS

Tim Preusker & staff

AGRICULTURE VICTORIA

Thank you



CSIRO Agriculture & Food
Everard J Edwards
Research Team Leader

+61 8 8303 8649
everard.edwards@csiro.au

Hort Innovation
Strategic levy investment

ALMOND FUND

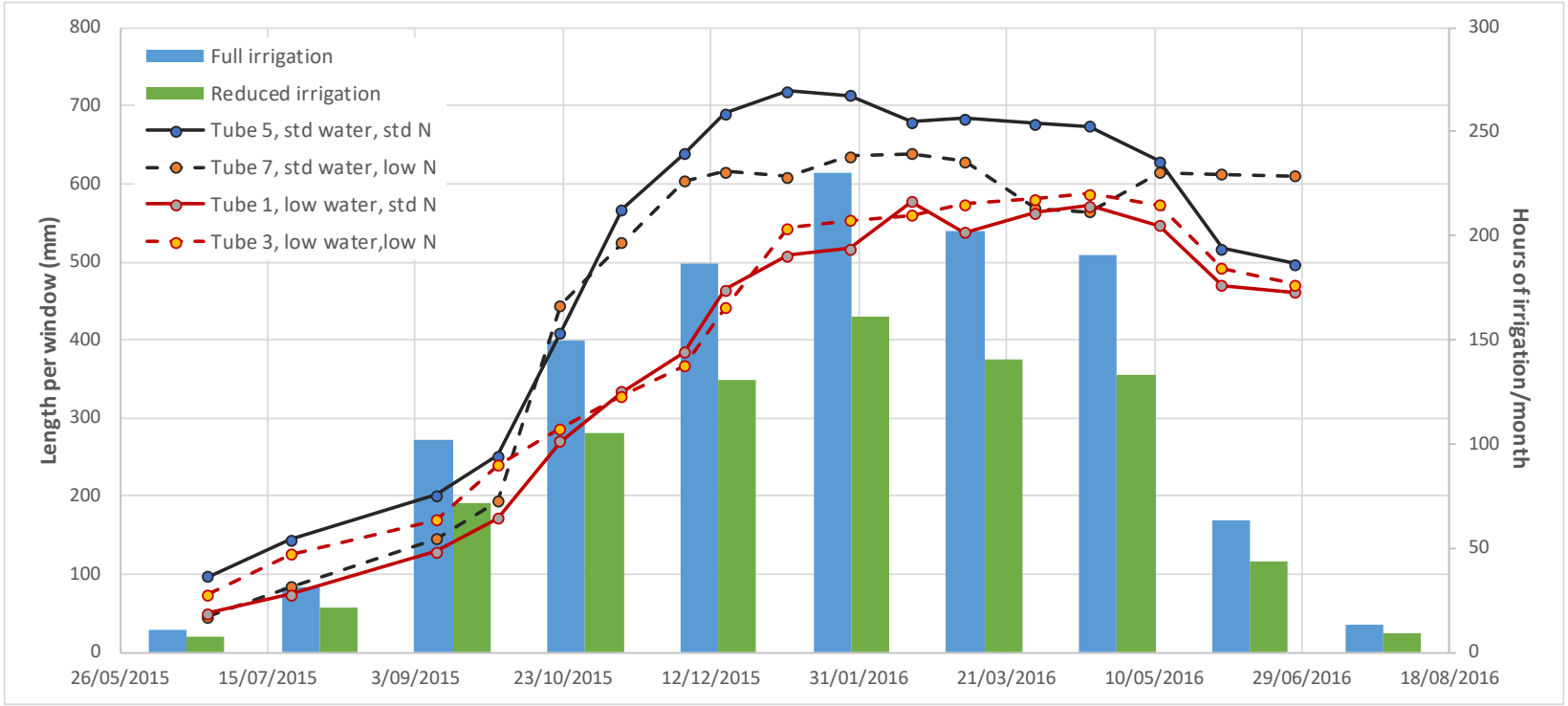
ALMOND BOARD OF AUSTRALIA

CSIRO

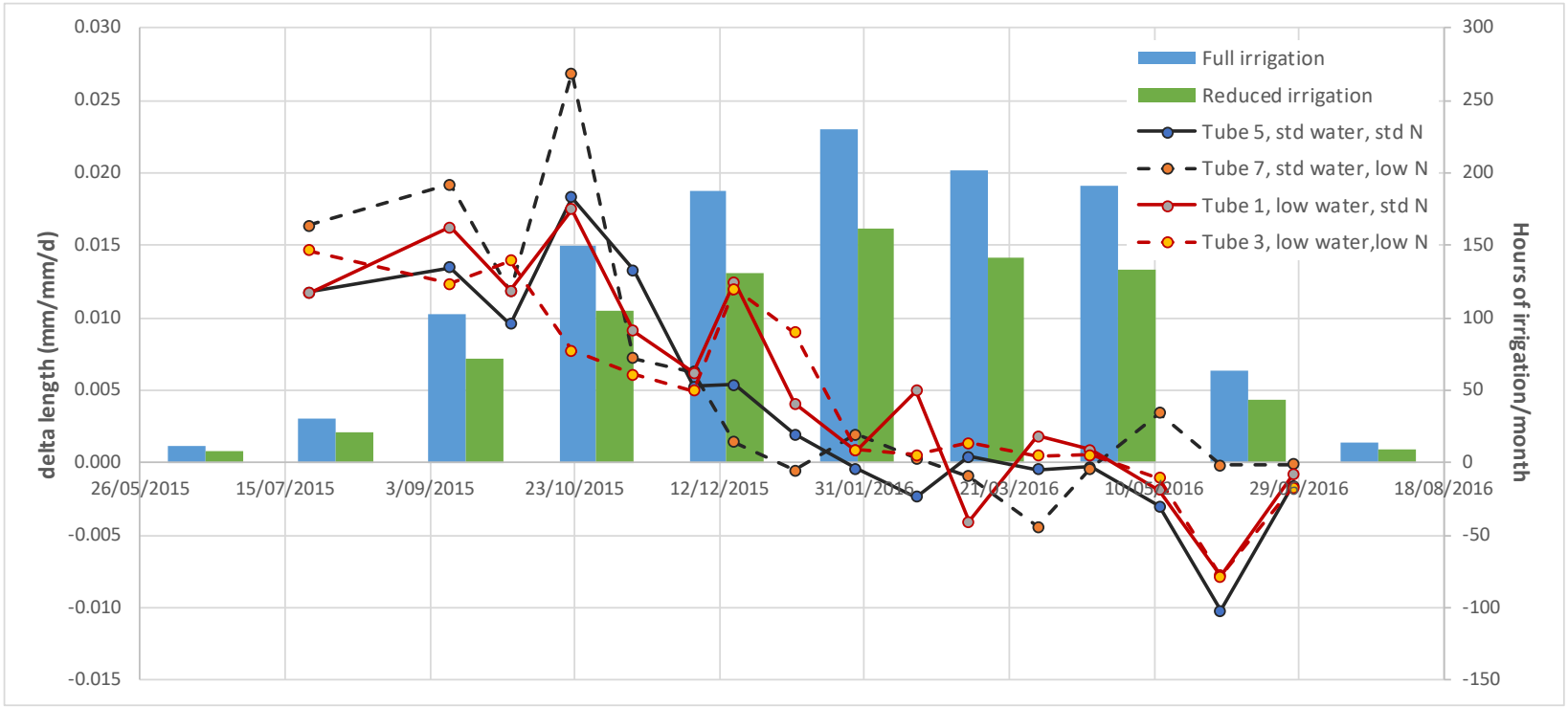
Root phenology: minirhizotrons

- Windows are repeatedly imaged over time.
- Can see development of root growth.

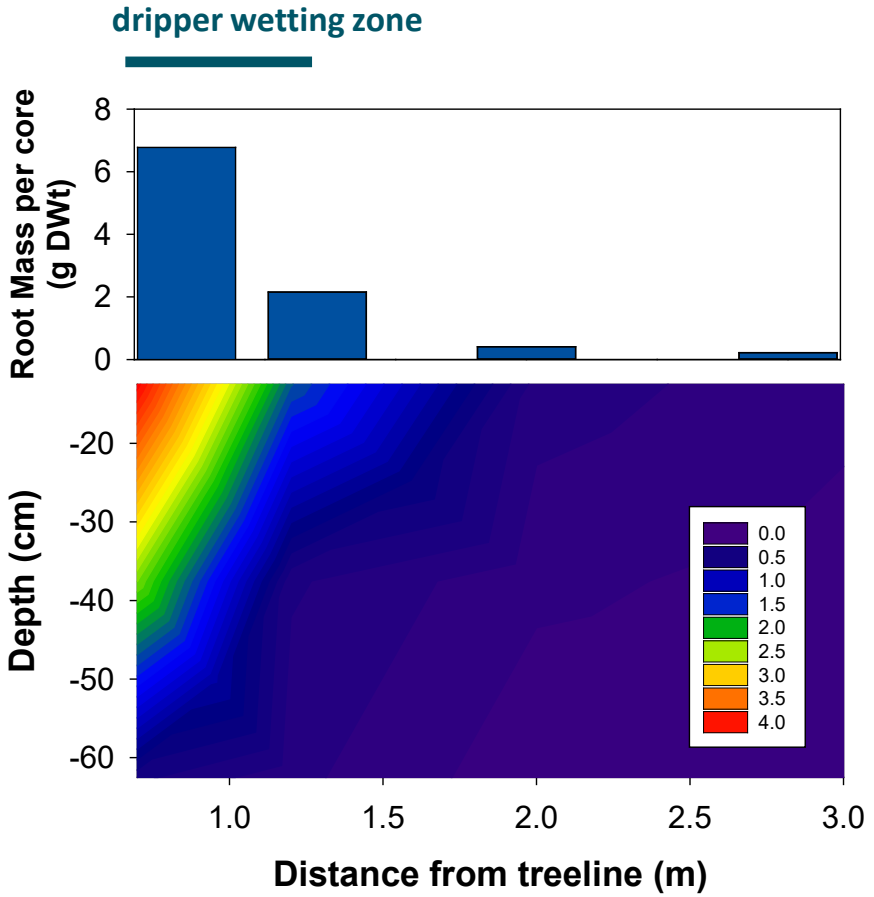
Root phenology update: root length



Root phenology update: root growth rate



Rooting zone: coring



CMV FARMS

CSIRO