Simulating GxExM in wheat

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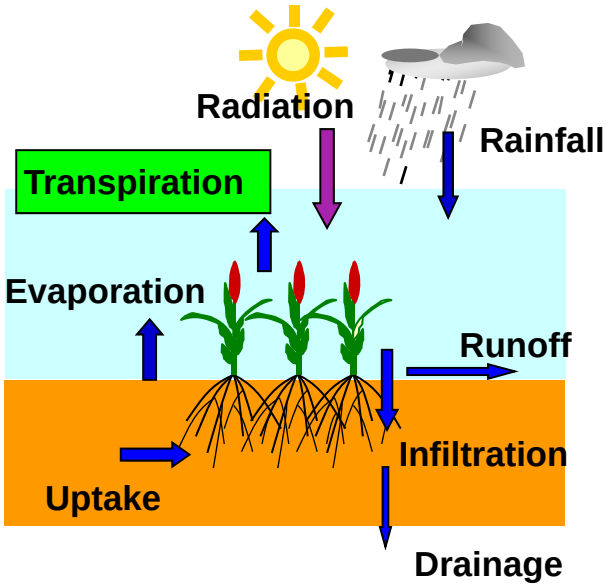
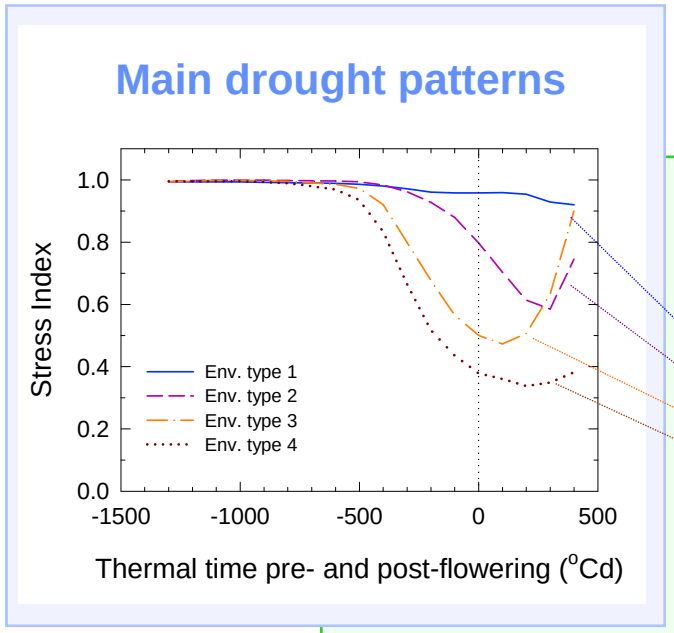
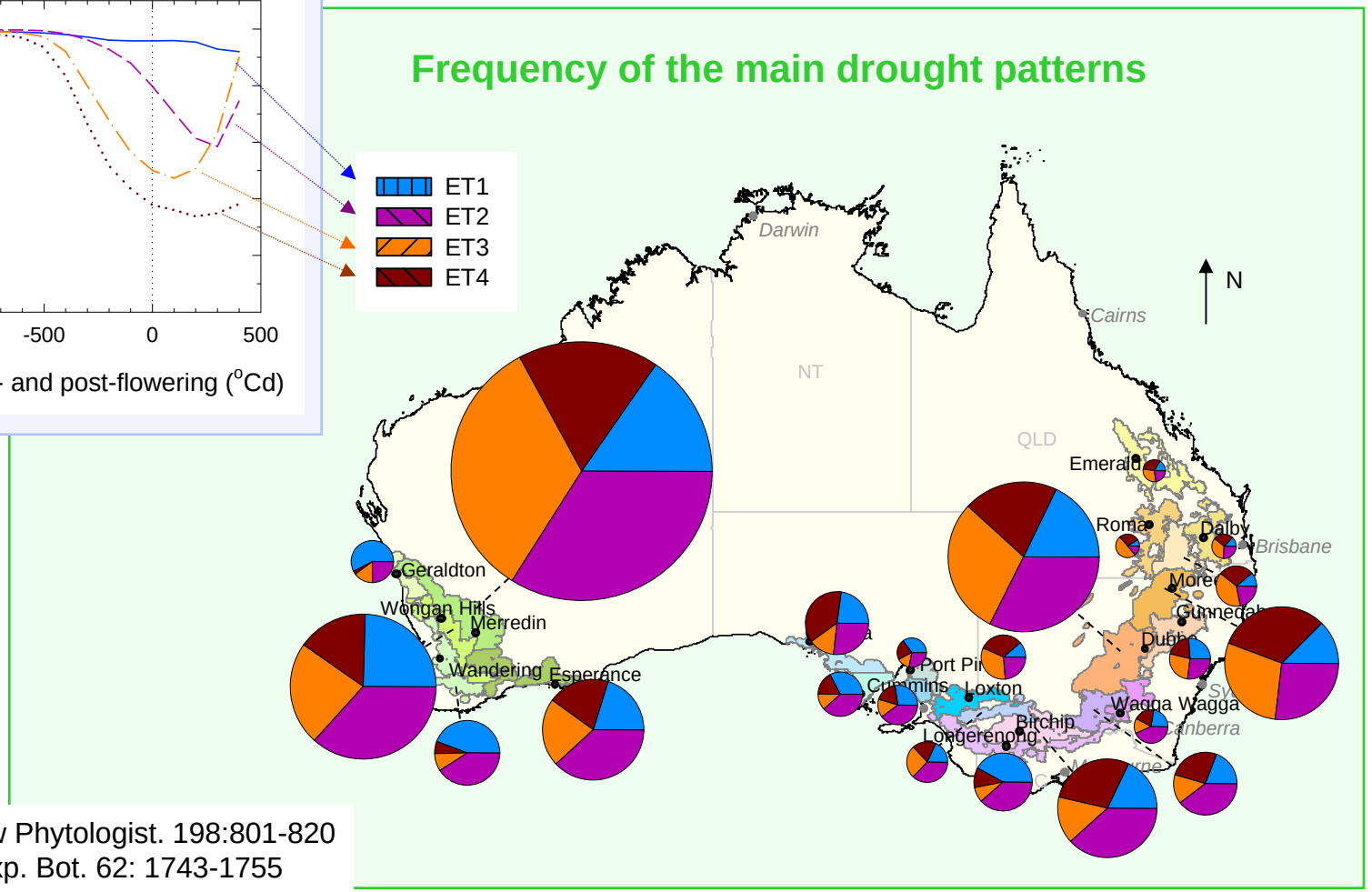
I – GxExM impact on drought patterns



Drought env. types in the Australian Wheatbelt





Chenu et al. 2013. New Phytologist. 198:801-820
Chenu et al 2011. J. Exp. Bot. 62: 1743-1755

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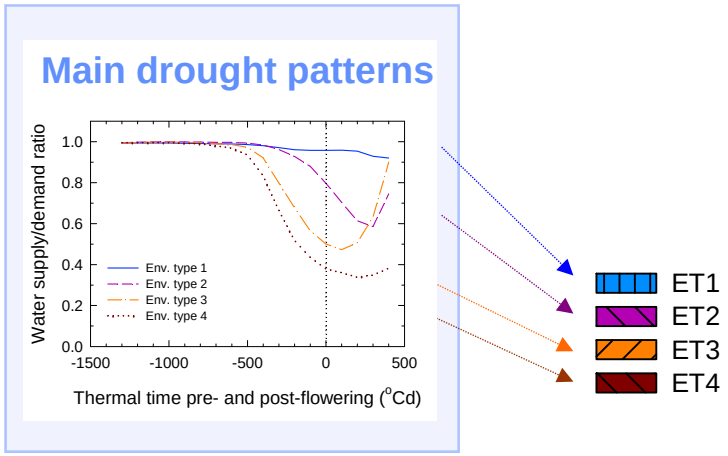

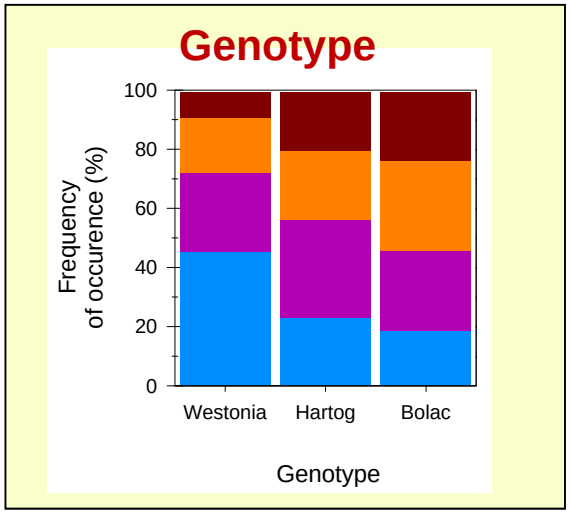

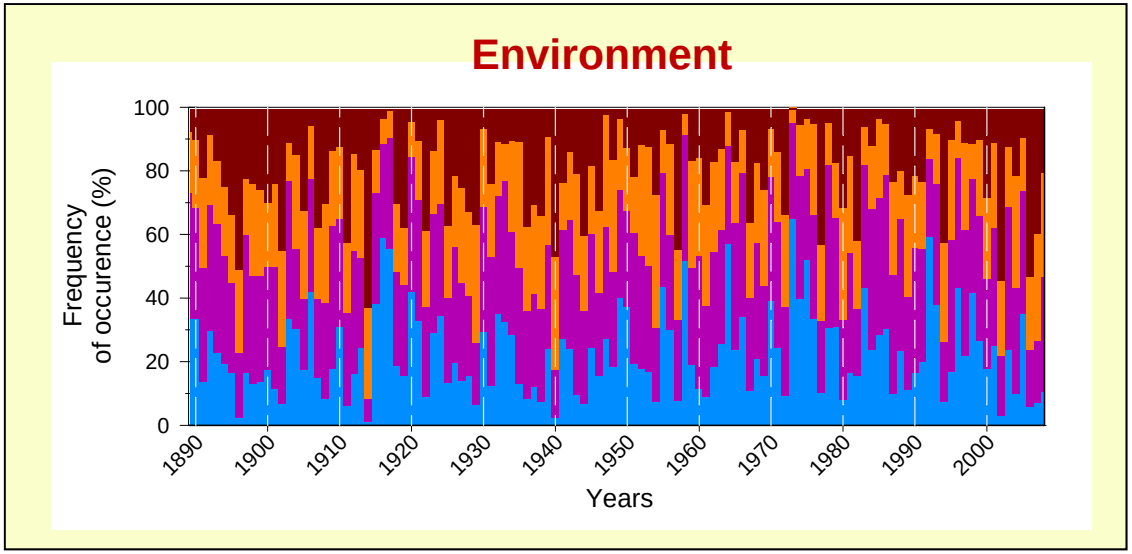

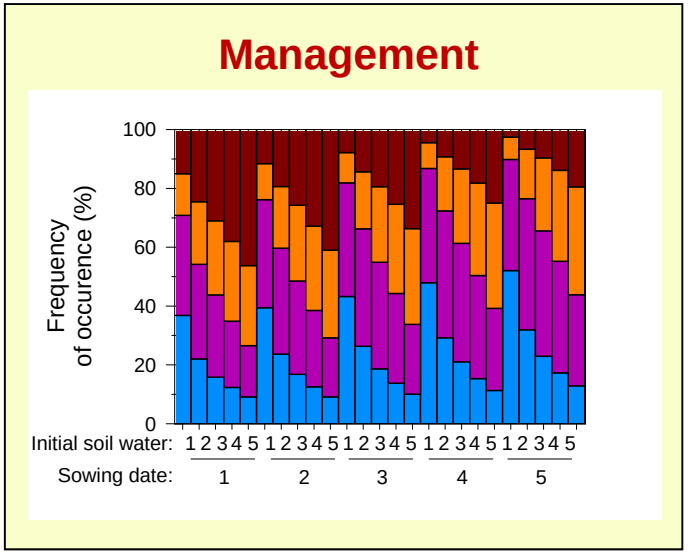

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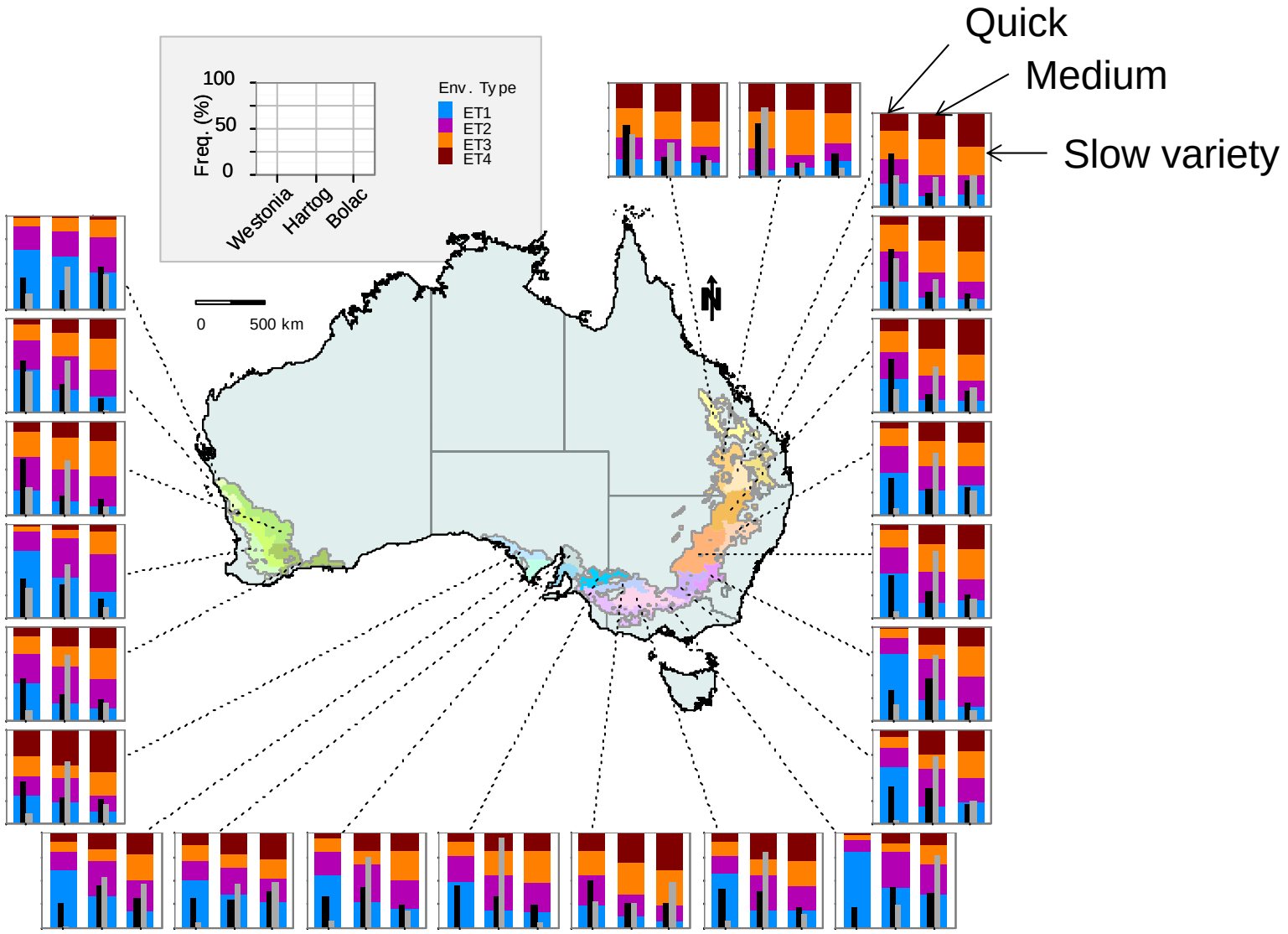
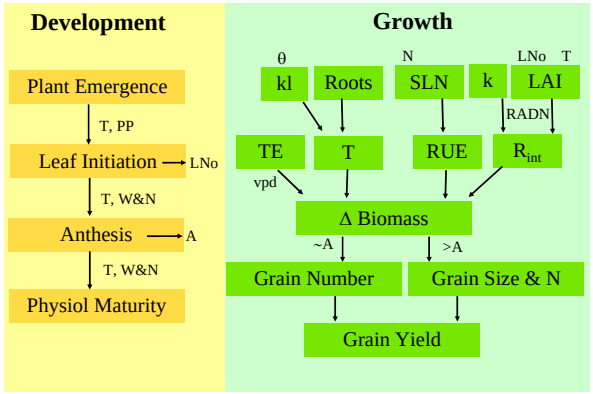
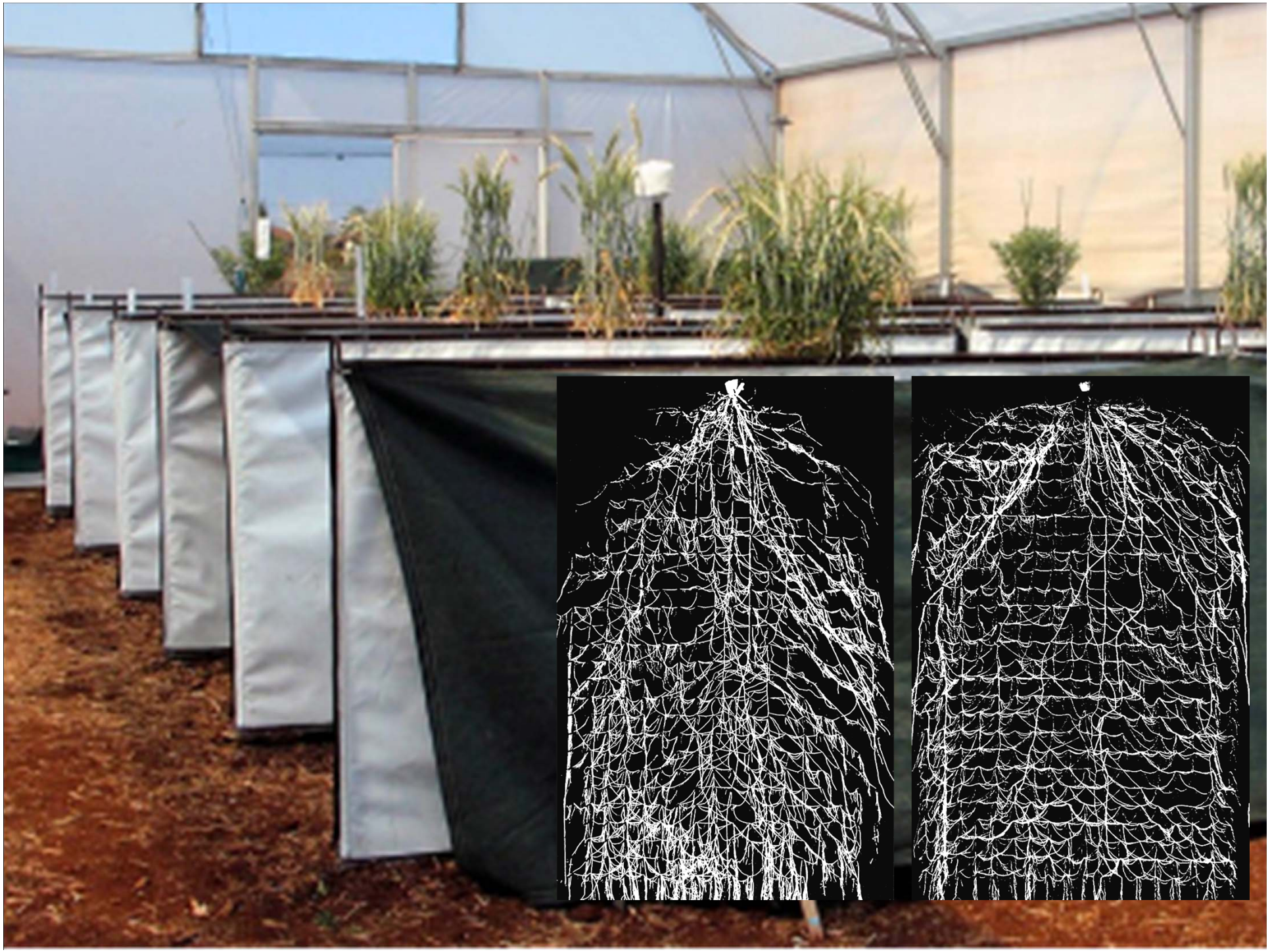


II - Trait value in targeted environments

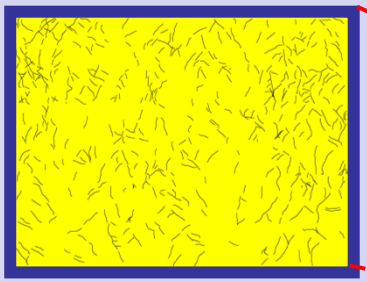


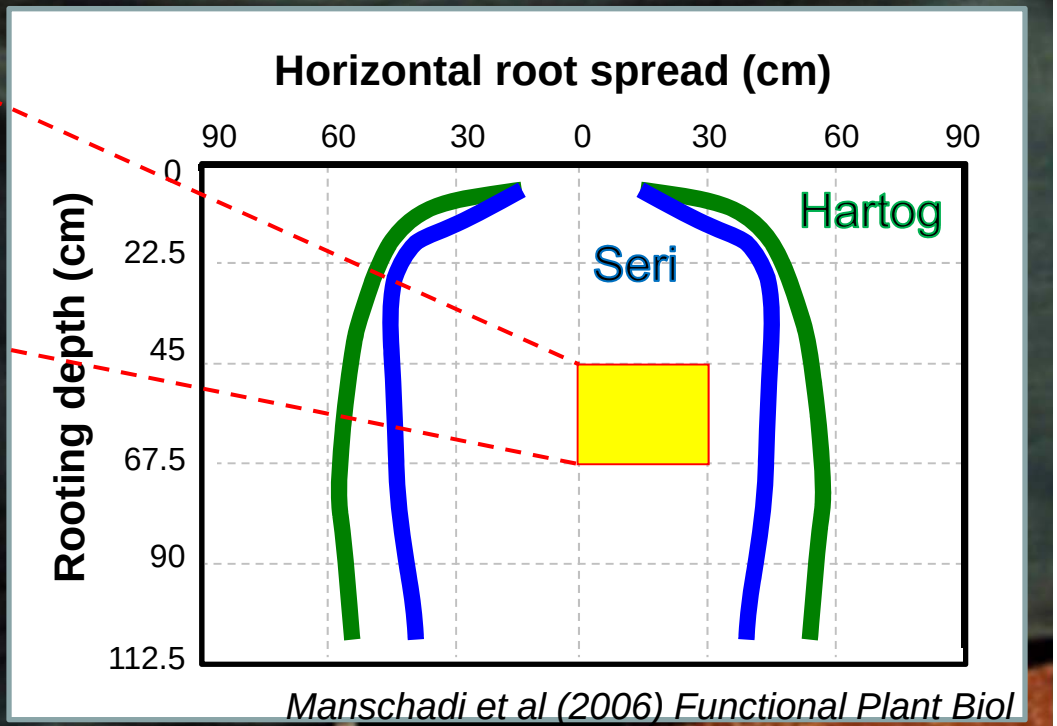


Trait 1- Better root repartition

Standard wheat Hartog

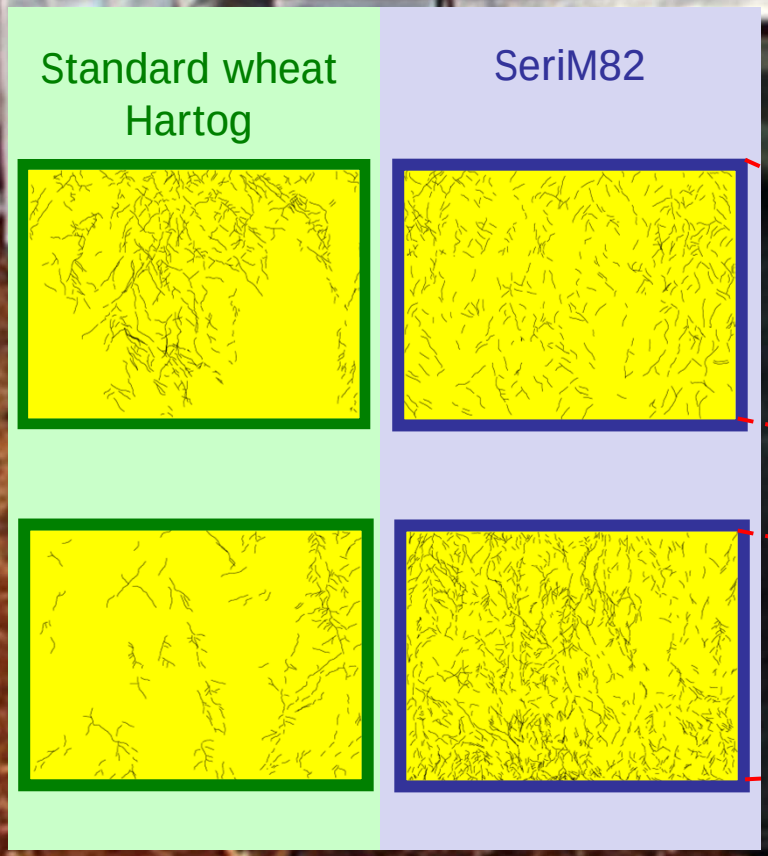
SeriM82

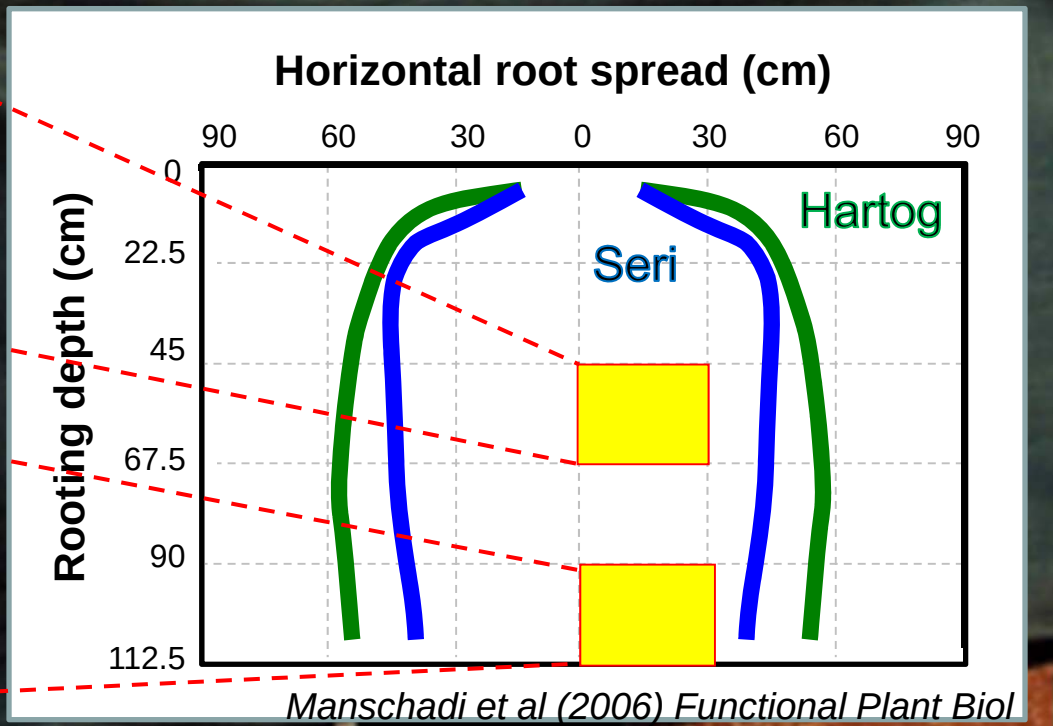




Manschadi et al (2006) Functional Plant Biol

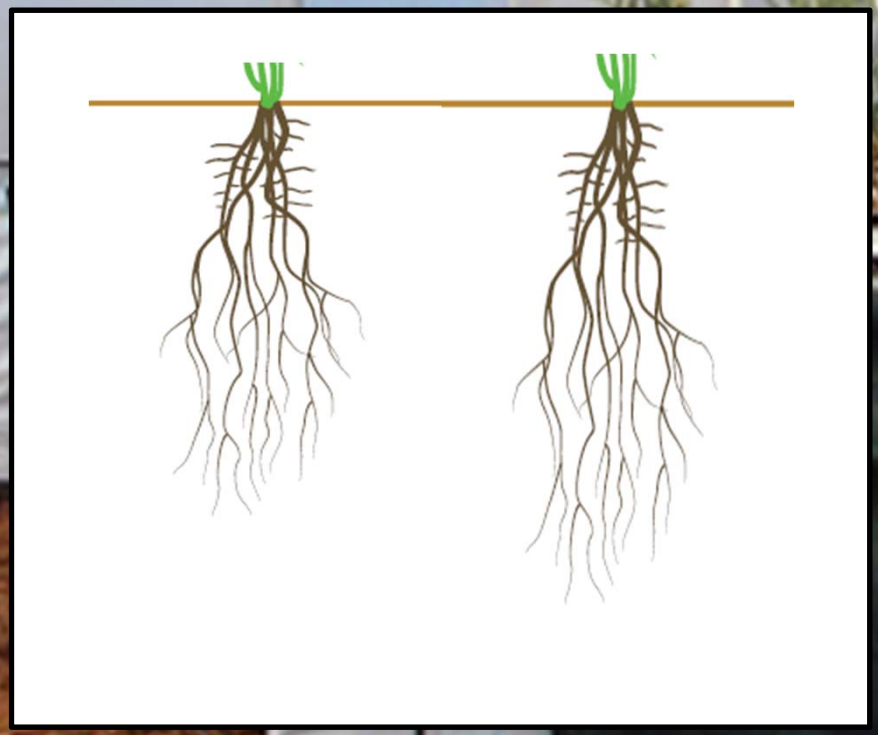
Trait 2- Better root occupancy at depth





Manschadi et al (2006) Functional Plant Biol

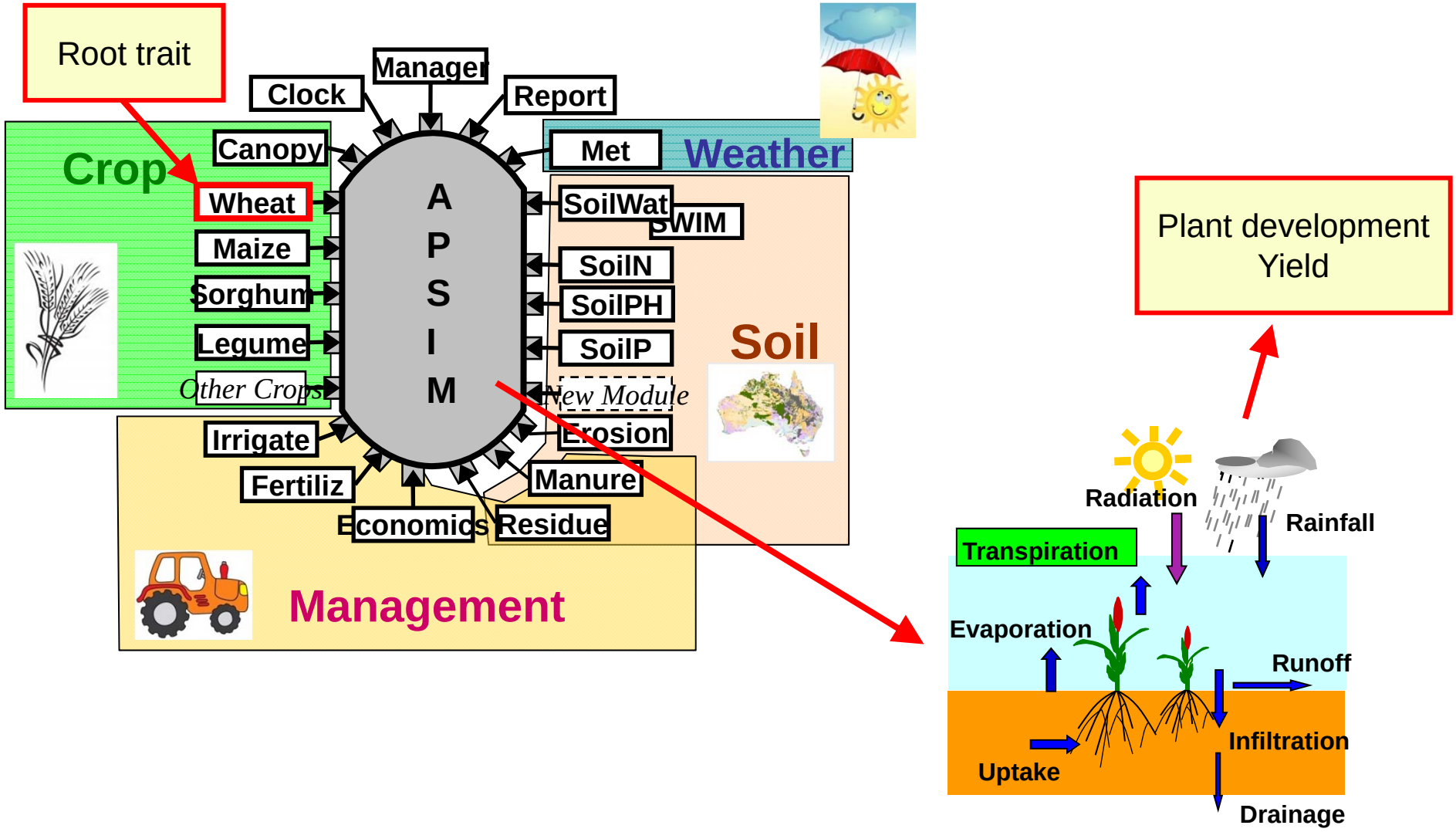
Trait 3- Quicker root growth rate



Root growth rate in wheat varies from 0.8 to 1.8 mm $^{o}Cd^{-1}$

(Kirkegaard and Lilley 2007 and 2011; Forrest et al. 1985; Barraclough 1984…)

Value of traits in target environments



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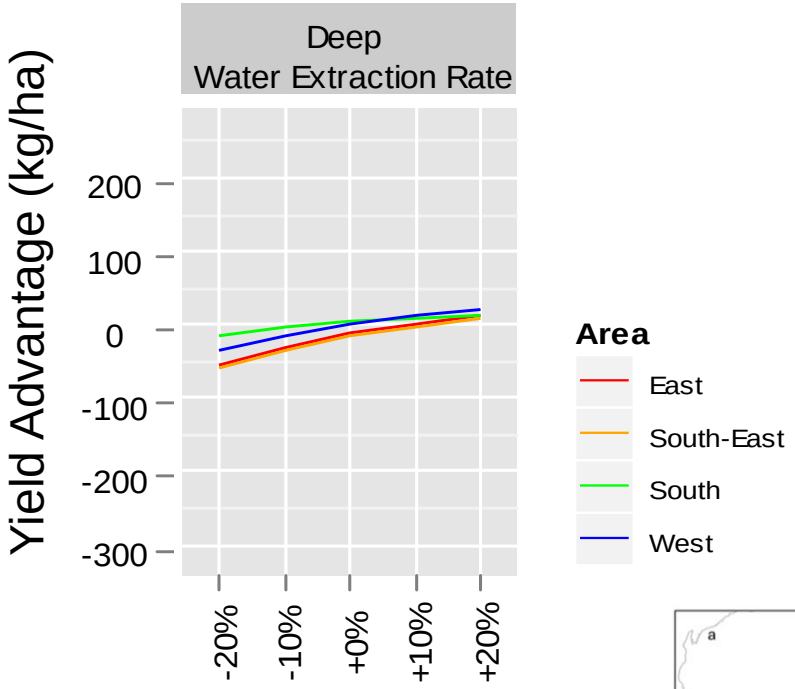

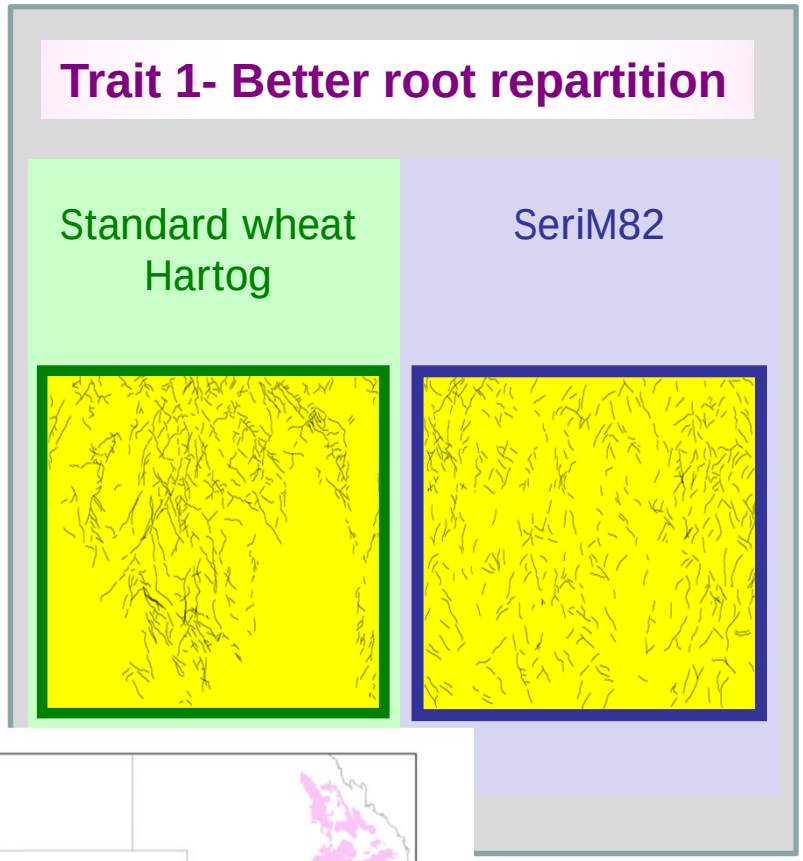

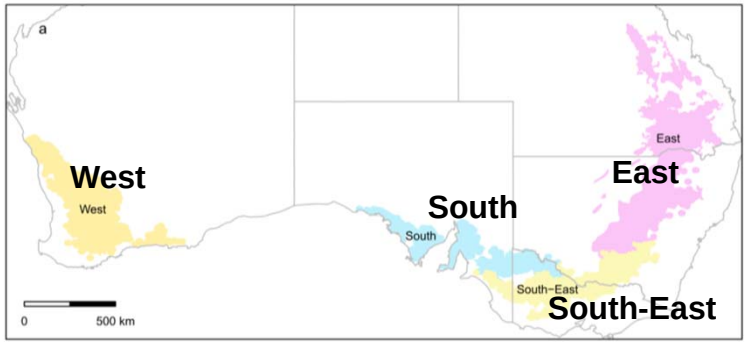

Veyradier, Chritopher & Chenu, unpublished

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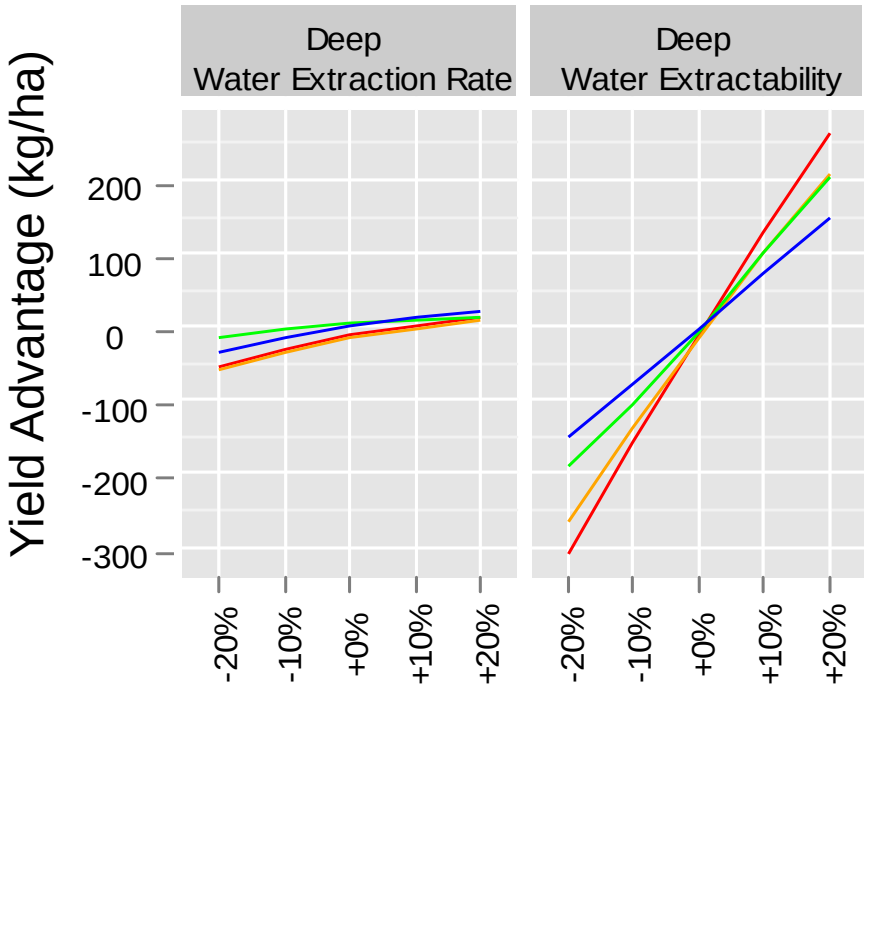

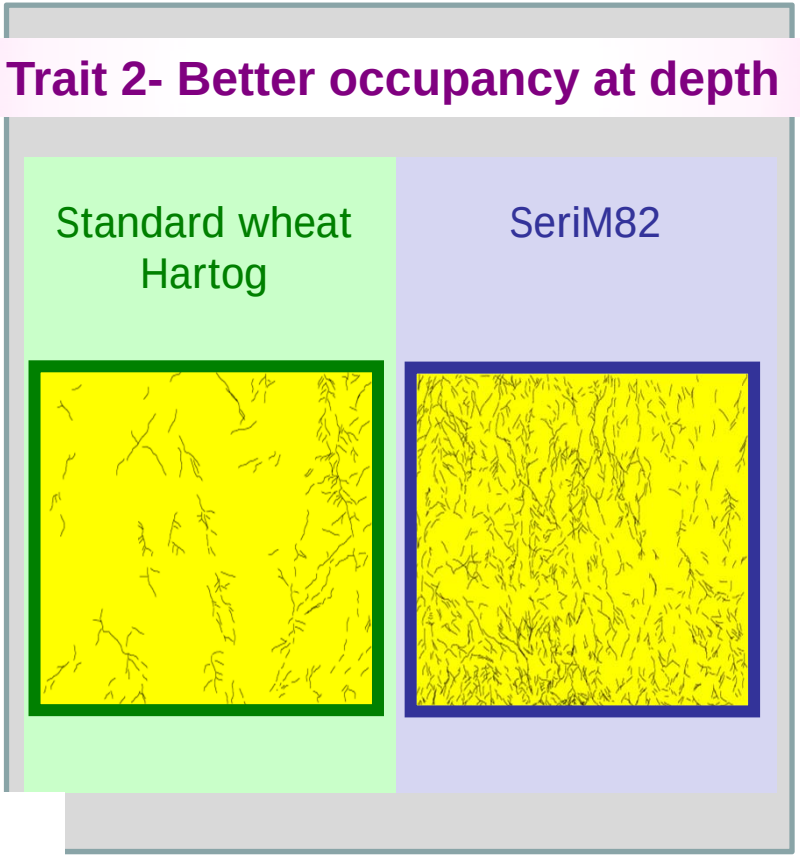

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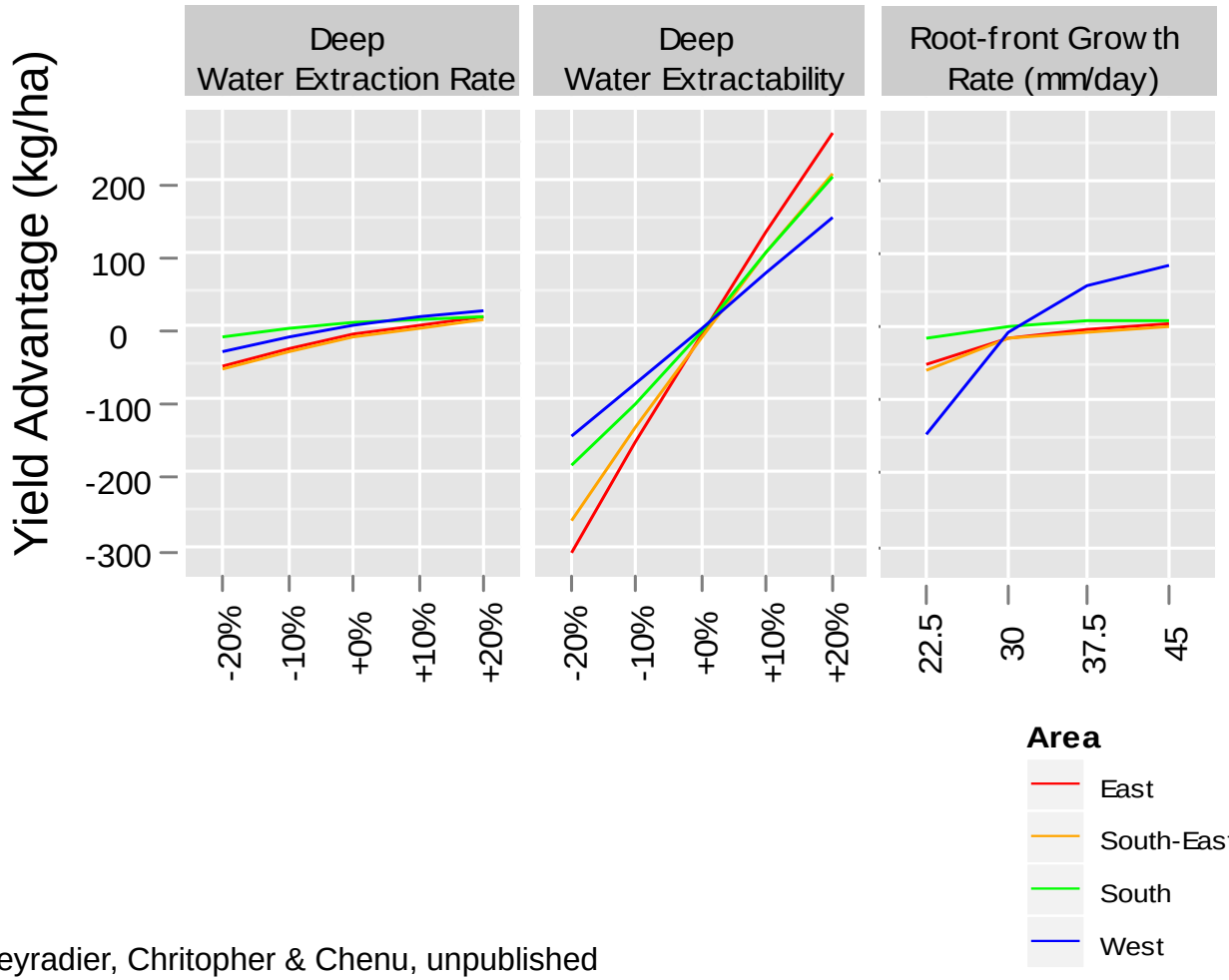
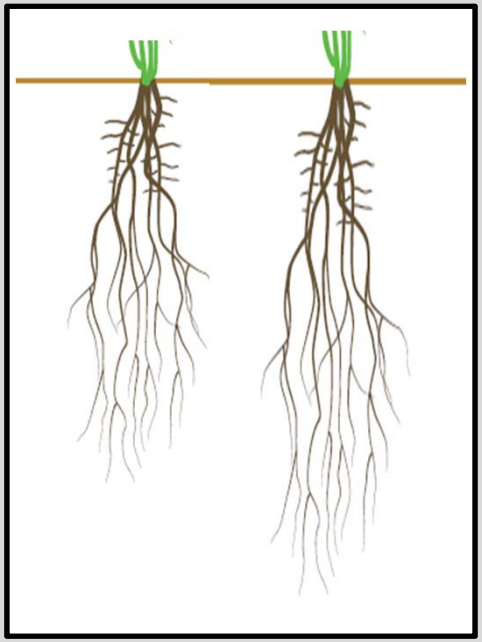


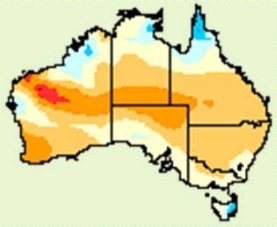
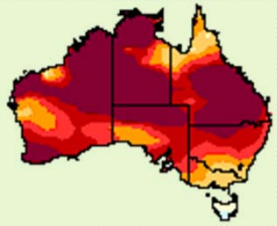
Trait 3
Quicker root growth rate



Veyradier, Chritopher & Chenu, unpublished

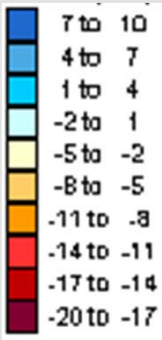
III – Explore novel systems (e.g. future climates)

4 future climate scenarios selected

	Precipitation	Emission scenario
Wet scenario	**GCM ECHAM5 (wet)** 	**A1FI - High sensitivity** By 2030: 455 ppm of CO_2 1.13ºC increase
		A2 - Low sensitivity By 2030: 451 ppm of CO_2 0.57ºC increase
Dry scenario	**GCM GFDL-21 (dry)** 	**A1FI - High sensitivity** By 2030: 455 ppm of CO_2 1.13ºC increase
		A2 - Low sensitivity By 2030: 451 ppm of CO_2 0.57ºC increase

- Projection of daily historical data (given by QCCCE)
- Baseline: 1889-2010
- 2 Emission scenarios
- 2 GCM models (representing the extreme projections at the national scale)

Rainfall change (%) per degree of global warming



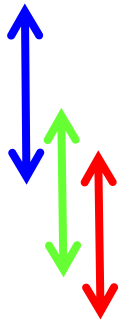
Adaptation to future climates

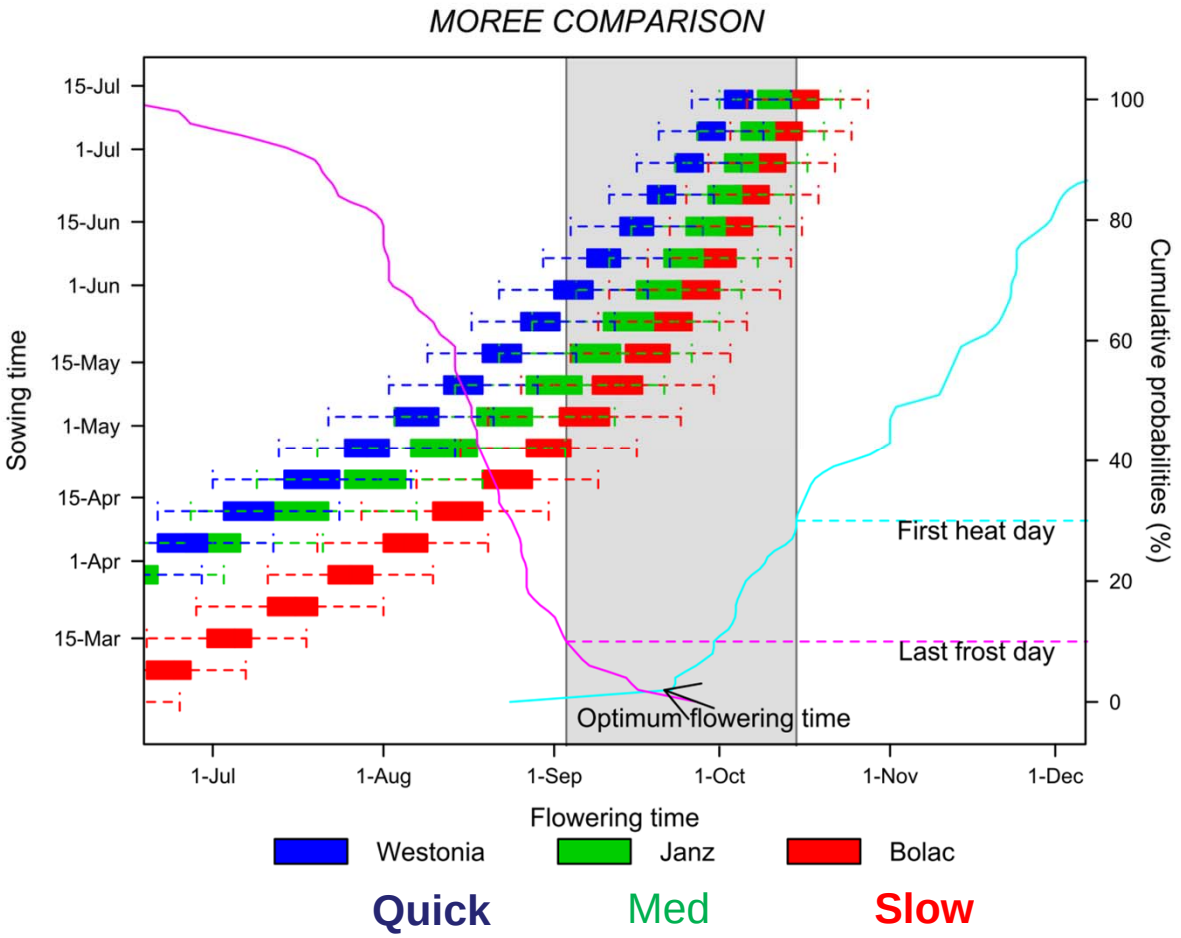
1- Adaptation of the management

2- Adaptation of the plant phenology

3- Adaptation to stresses (e.g. drought, heat…)

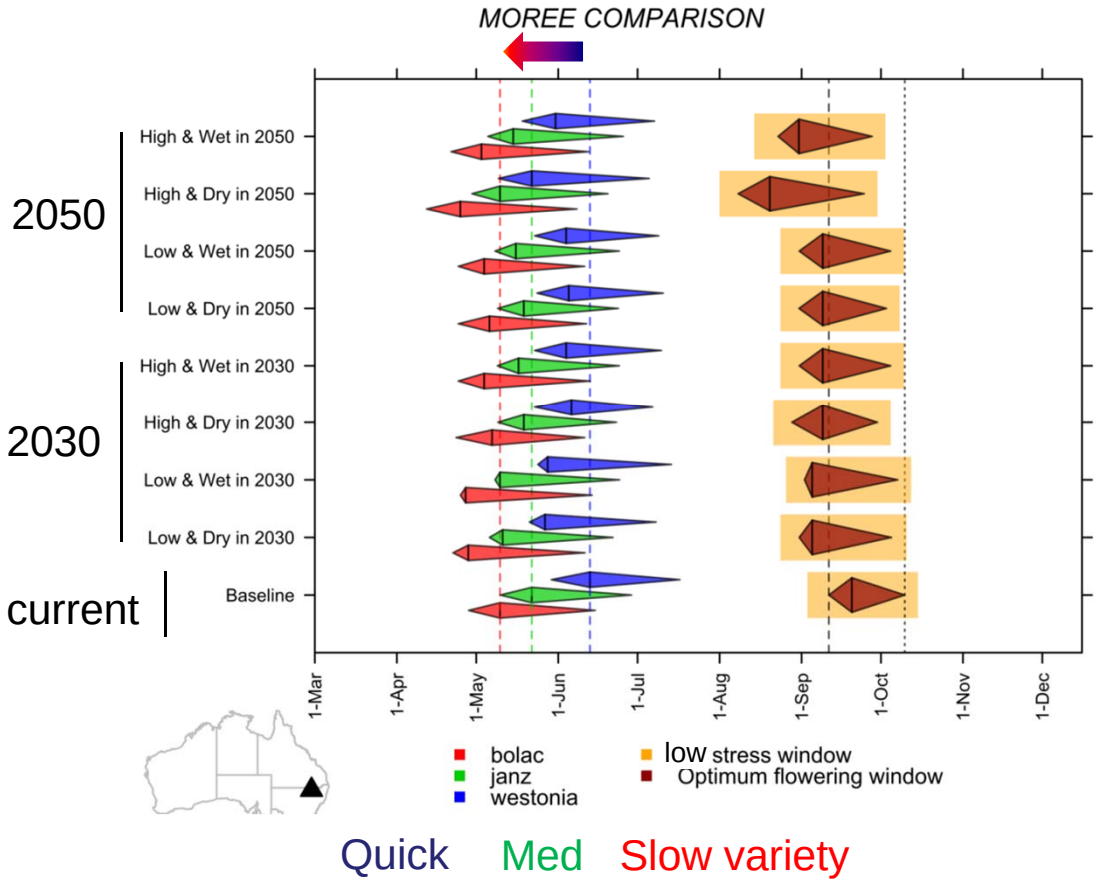
Optimum sowing and flowering time as limited by frost and heat stresses (current cl.)





Zheng et al (2012) Global Change Biology

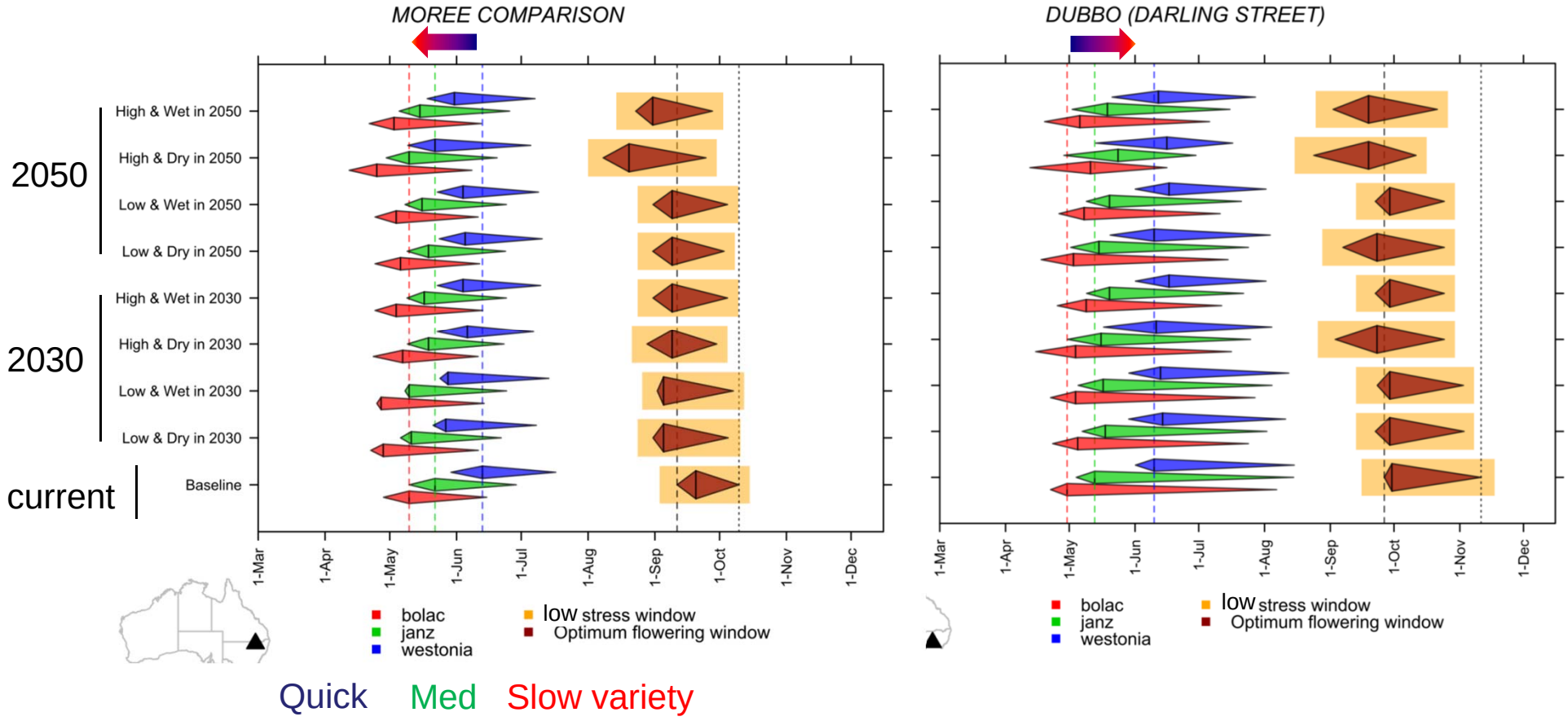
Future: optimum sowing window will need to shift



- Earlier flowering and sowing window (to escape frost and heat)

Zheng et al (2012) Global Change Biology

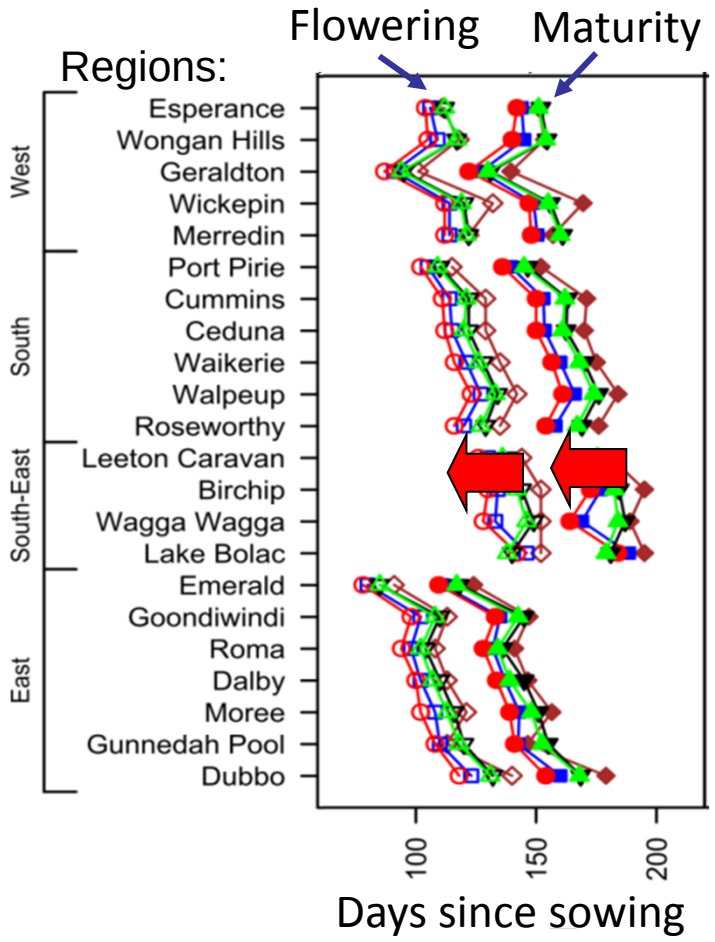
Future: optimum sowing window will need to shift
But it won't always be simple!



Quick Med Slow variety

Zheng et al (2012) Global Change Biology

Future: shorter growing season - less time for biomass accumulation



- By 2050
  - Growing season shorter by 46 d max

  (with a model that under-estimates heat effect)
  - Loss of biomass production
  - How do we adapt phenology and develop tolerance for higher temperature conditions?

◇ ◆ Baseline ▽ ▼ Low emission & Wet △ ▲ Low emission & Dry □ ■ High emission & Wet ○ ● High emission & Dry

Zheng et al. 2012
Global Change Biology18: 2899–2914

Conclusion – Perspective
Opportunities driven by GxExM modelling

1- Environment characterisation

- What is the nature of the environments that commercial crops are/will experience?
- Which environments are we dealing in experimental/breeding trials?
- Which environment type(s) should we target? e.g. irrigation management

2- Which adaptive traits to target?

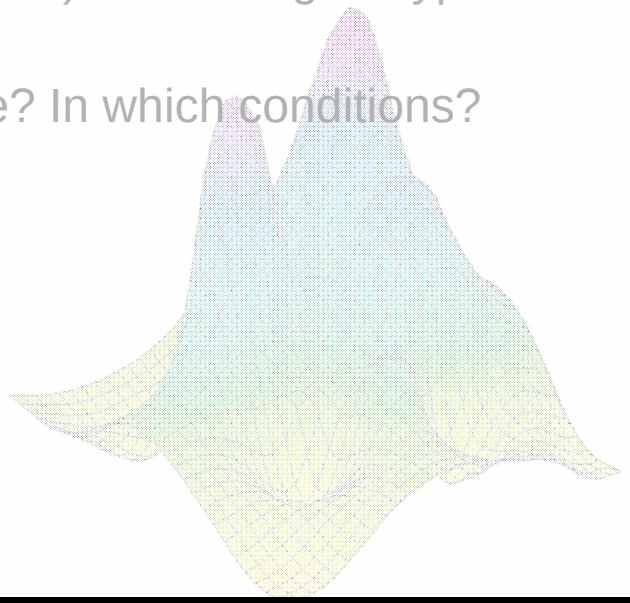
- Which impact have traits (singly or in combination) and their genotypic variability in the targeted environments?
- Which component trait(s) should we phenotype? In which conditions?

3- Linkage with breeding models

- Fix more efficiently interesting genes and traits

4- Explore to new horizons

- Search for adapted managements, locations…
- Impact of future climates



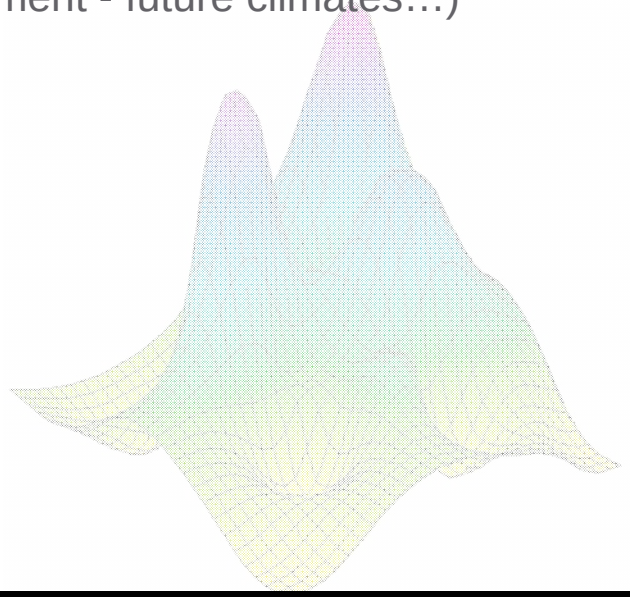
Conclusion – Perspective
Opportunities driven by GxExM modelling

This relies on

- **robust model** with some **strong physiological basis**, where integrated traits results from emergent properties (as in reality)

On-going research

- Better understanding of trait physiology (heat and drought response)
- Improved crop modelling capability (trait assessment - future climates…)



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