

Genetics of lentil phenology and interactions with yield

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Lentil Phenology Questions

- What alleles are present in Australian varieties and germplasm?
- What alleles are available in collections from around the world?
- What effect do the alleles have on flowering time?
- How do these alleles relate to yield?



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Methods

- *Measure phenology in controlled conditions with Australian and international material*
- *Measure phenology of Aus varieties in the field*
- *Determine shifts in phenology with breeding*
- *Determine relationships with yield*



Line	Experiment	Origin
Indianhead (1988f)	1,2	Canada
Cobber (1993)	1,2	Australia
Digger (1993)	1	Australia
Matilda (1993)	1	Australia
Aidinga (1996)	1,2	Australia
Northfield (1996)	1,2	Australia
Cassab (1998)	1,2	Australia
Cumra (1998)	1	Australia
Nugget (2000)	2	Australia
Boomer (2006)	2	Australia
Nipper (2008)	2	Australia
PBA Flash (2009)	1,2	Australia
Gramplans (2010)	2	Australia
PBA Blitz (2010)	1,2	Australia
PBA Jumbo (2010)	1,2	Australia
PBA Ace (2011)	1,2	Australia
PBA Bolt (2011)	1,2	Australia
Mt Byron (2011)	1	Australia
Materno (2011)	1	Australia
PBA Herald (2012)	1,2	Australia
PBA Hurricane (2013)	1,2	Australia
PBA Jumbo2 (2014)	1,2	Australia
PBA Greenfield (2014)	1,2	Australia
PBA Giant (2014)	1,2	Australia
CIPAL1701 (2019) ^f	1	Australia
PBA HallmarkXT (2019)	2	Australia
PBA Highland (2019)	1,2	Australia
CDC Ruby	2	Canada
Commando	2	Canada
Precoz	1	Argentina
SP1333	1,2	Argentina
KYE	1	Ethiopia
ILL 5888	1	Bangladesh
Eston	1,2	Canada
Laird	1	Canada
ILL 2024	1	Ethiopia
ILL 10748	1	ICARDA
ILL 6002	1	ICARDA
ILL 7663	1	ICARDA
ILL 2601	1	India
Shasta	1	USA
ILL 8006	1	USA
Palouse	1	USA

Australian varieties and international germplasm.

Experiment 1 was Utas growth chamber and 2 was field.



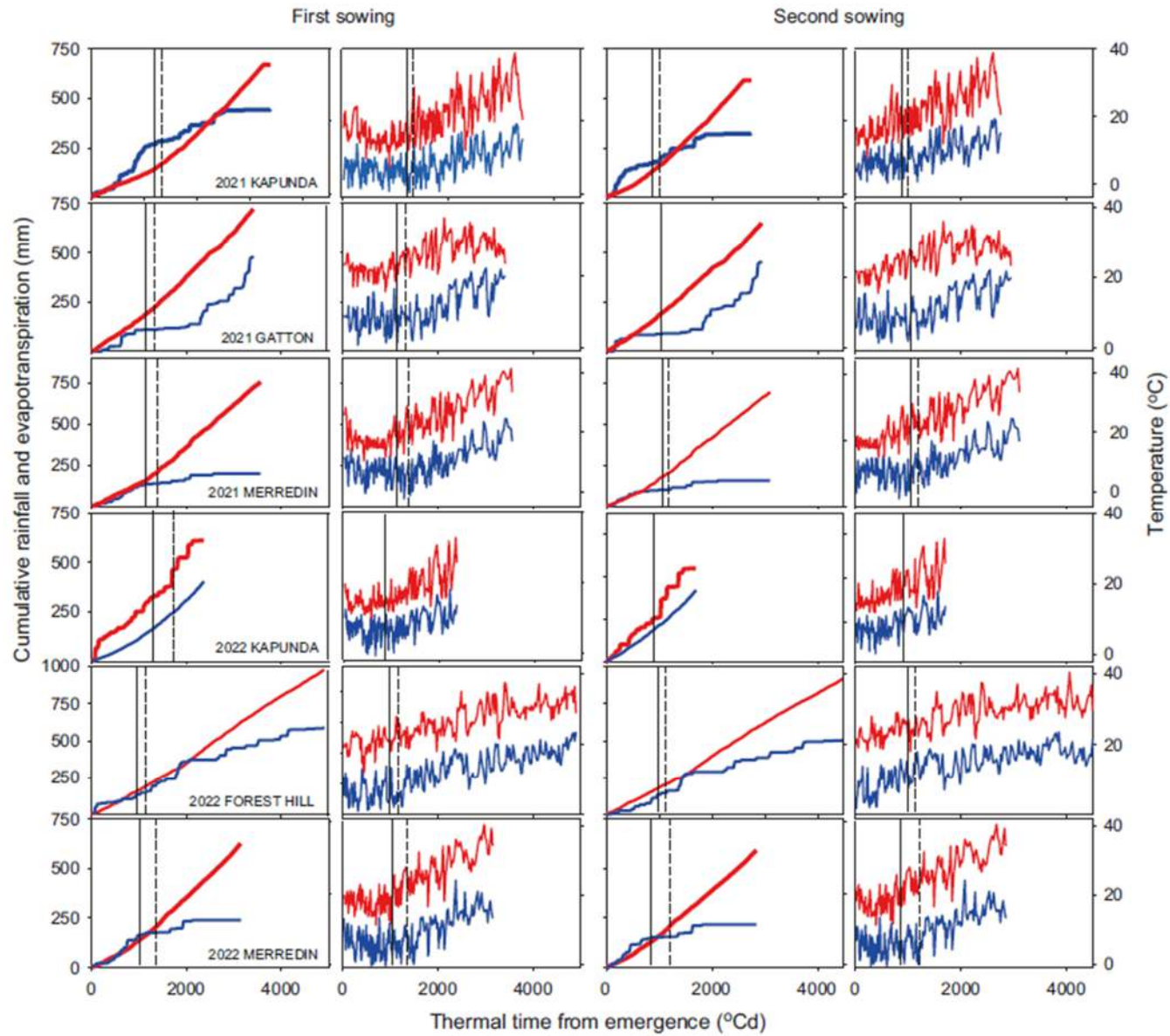
UTas Controlled conditions

Short day = 8 hours light

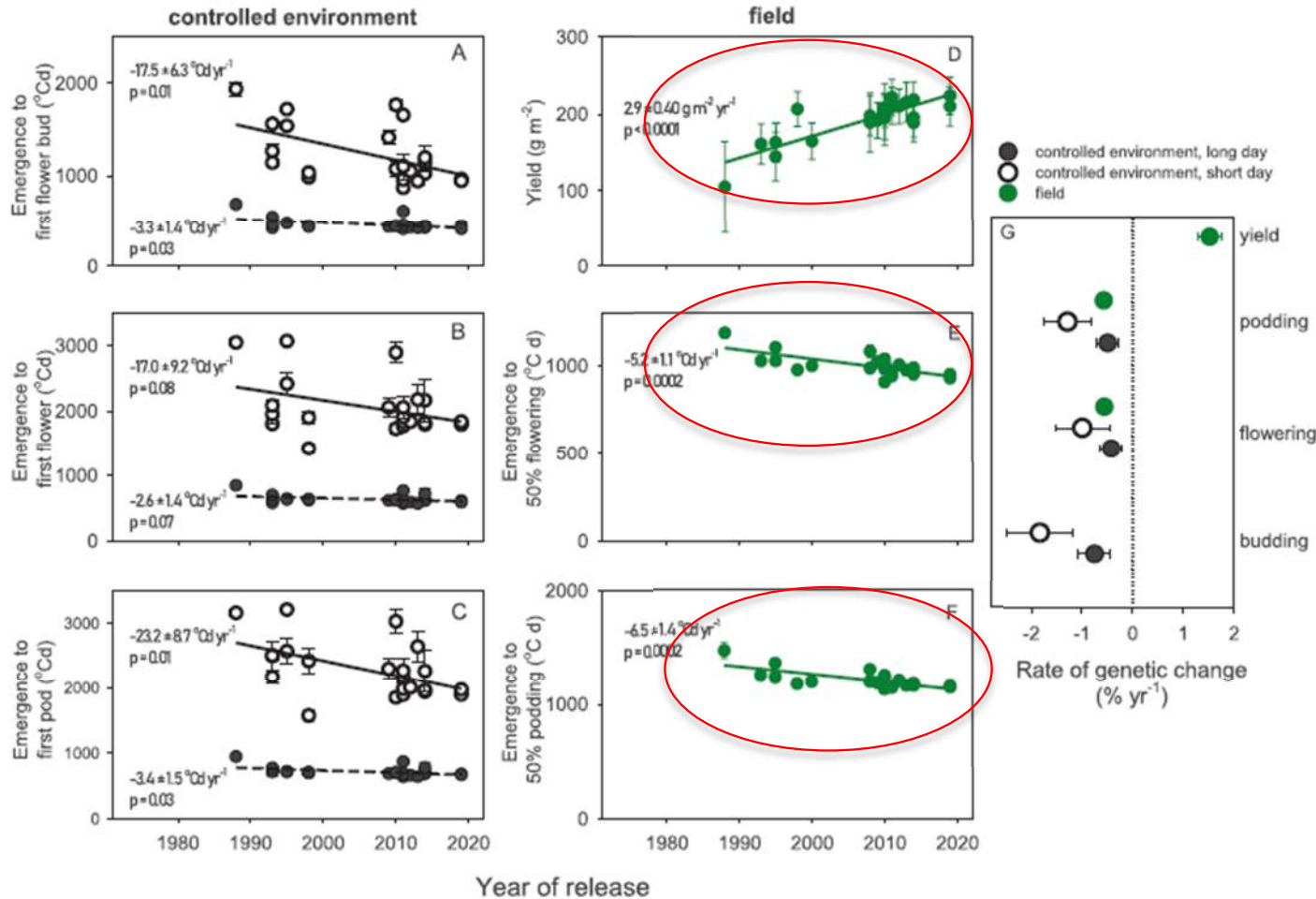
Long day = 16 hours light



Field environments



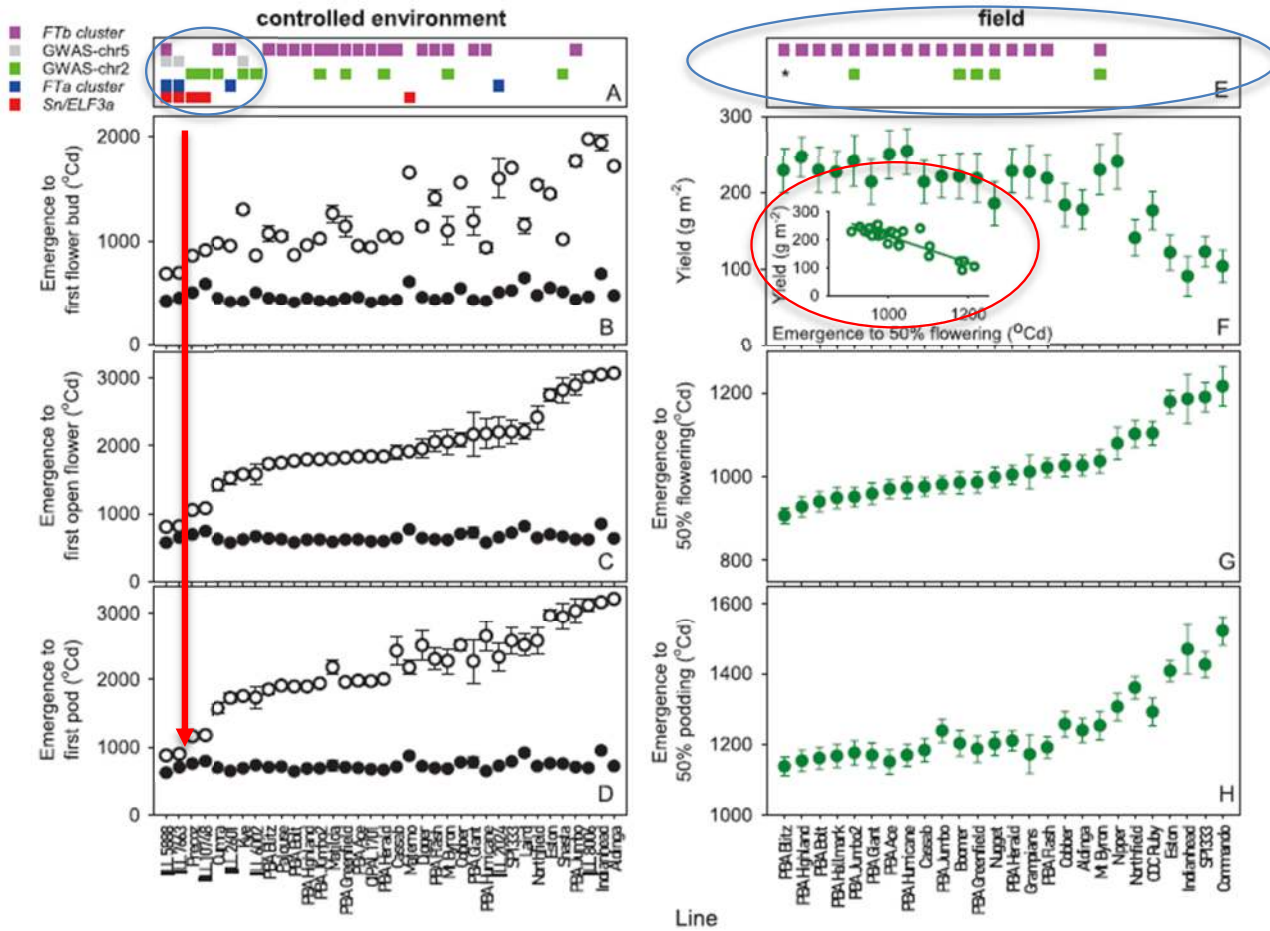
Results



- Breeding has improved response to **short day** conditions **reducing time to flower and pod**.
- This is associated with **increased yield**.



Results



Australian material only has two of five potential flowering alleles.



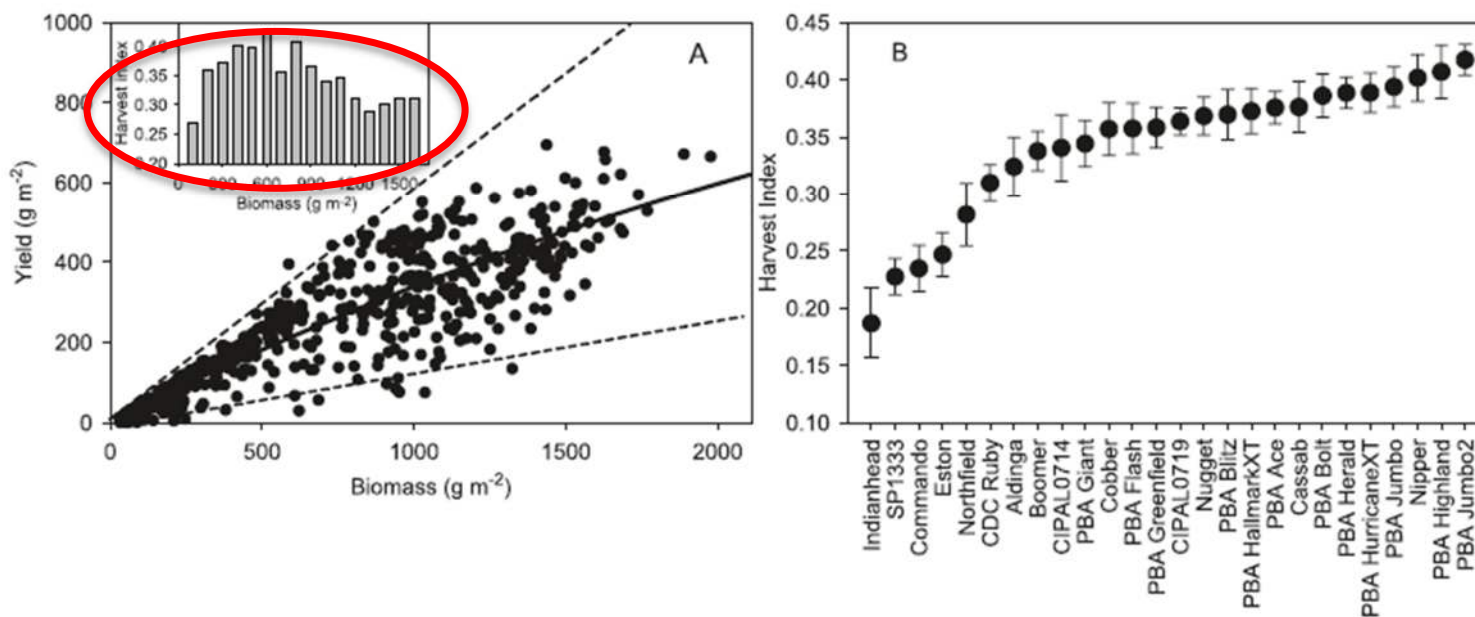


Fig. 4. Relationship between lentil yield and biomass in field conditions. (A) Relationship between yield and biomass pooled across 11 environments. Dashed lines are the bounds of harvest index: inferior=0.1, superior=0.58. The solid line is the quadratic function: $y = -4.98 + 0.37x - 0.00004x^2$, $r^2 = 0.81$, $P(\text{quadratic term}) = 0.005$. Inset is the average harvest index calculated for each 100 g m⁻² biomass category. (B) Harvest index (ratio of yield and biomass) of each variety pooled across 11 environments. Error bars are two standard errors of the mean.

Table 2. Phenotypic correlation between crop traits for 25 lentil lines grown in 11 environments

	Yield	Seed number	Seed size	Biomass	Harvest index	Flowering	Podding
Seed number	0.92***						
Seed size	0.08	-0.22***					
Biomass	0.90***	0.86***	0.01				
Harvest index	0.30***	0.22***	0.16**	-0.07			
Flowering	0.47***	0.54***	-0.19***	0.62***	-0.31***		
Podding	0.19***	0.27***	-0.20***	0.40***	-0.43***	0.82***	
Time from flowering to podding	-0.42***	-0.39***	-0.04	-0.29***	-0.25***	-0.17**	0.42***

*** $P < 0.001$, ** $P < 0.01$.

Early flowering and podding is associated with higher yield, HI.

Time from flowering to podding associated with lower yield.

Decoupling of growth and yield.

Matching variety to environment and season curveballs.....



Matching variety to environment and season curveballs.....



Takeaways

- In the environments we tested, lentil yield is associated with earlier flowering.
- Australian germplasm has two of the five potential alleles available.
- Yield improvement may be achieved by introgression of additional early alleles or provide additional breeding options.



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