OPTIMISATION OF CANOLA PHENOLOGY IN DIVERSE AUSTRALIAN GROWING ENVIRONMENTS USING GENOMICS

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Optimising Canola Phenology using Genomics

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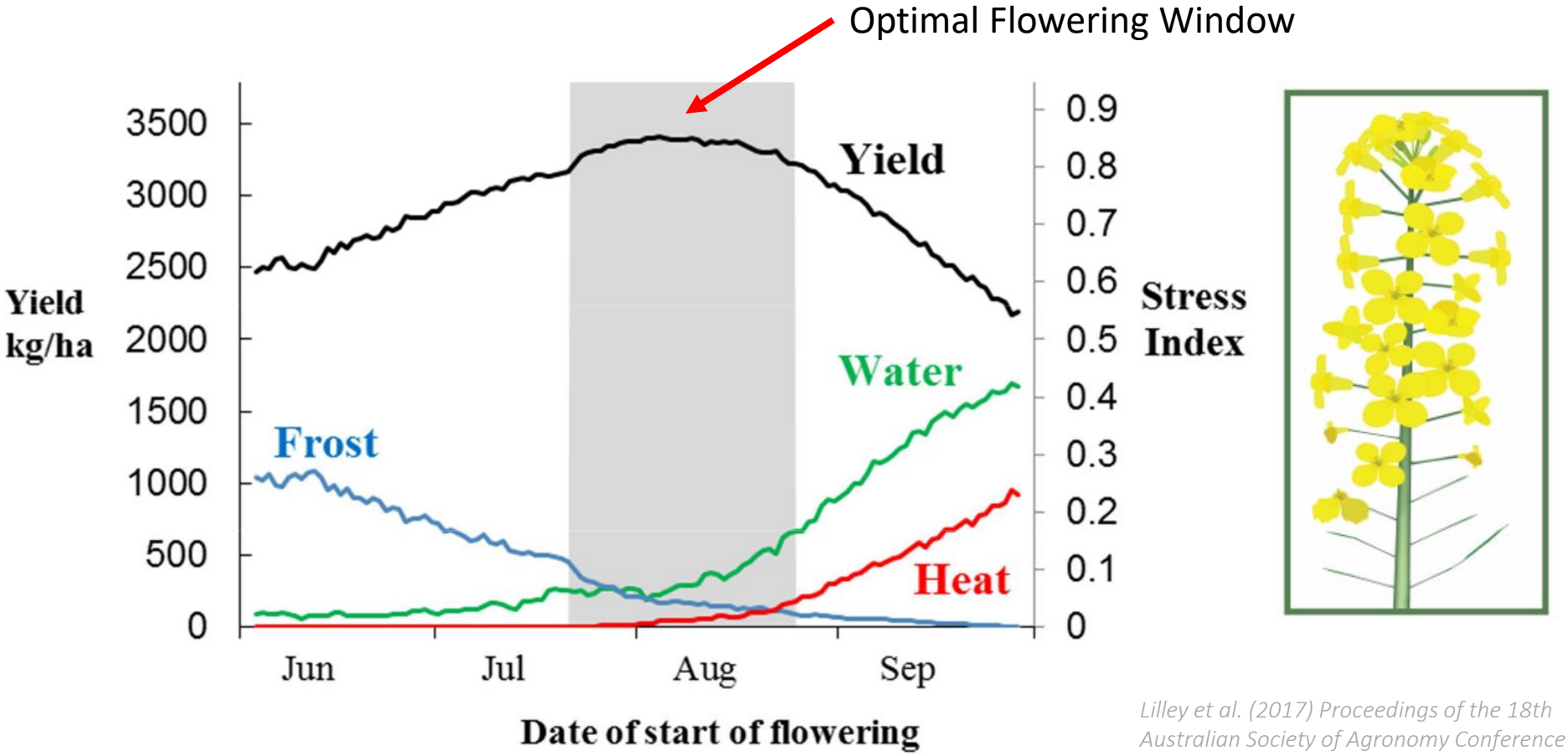
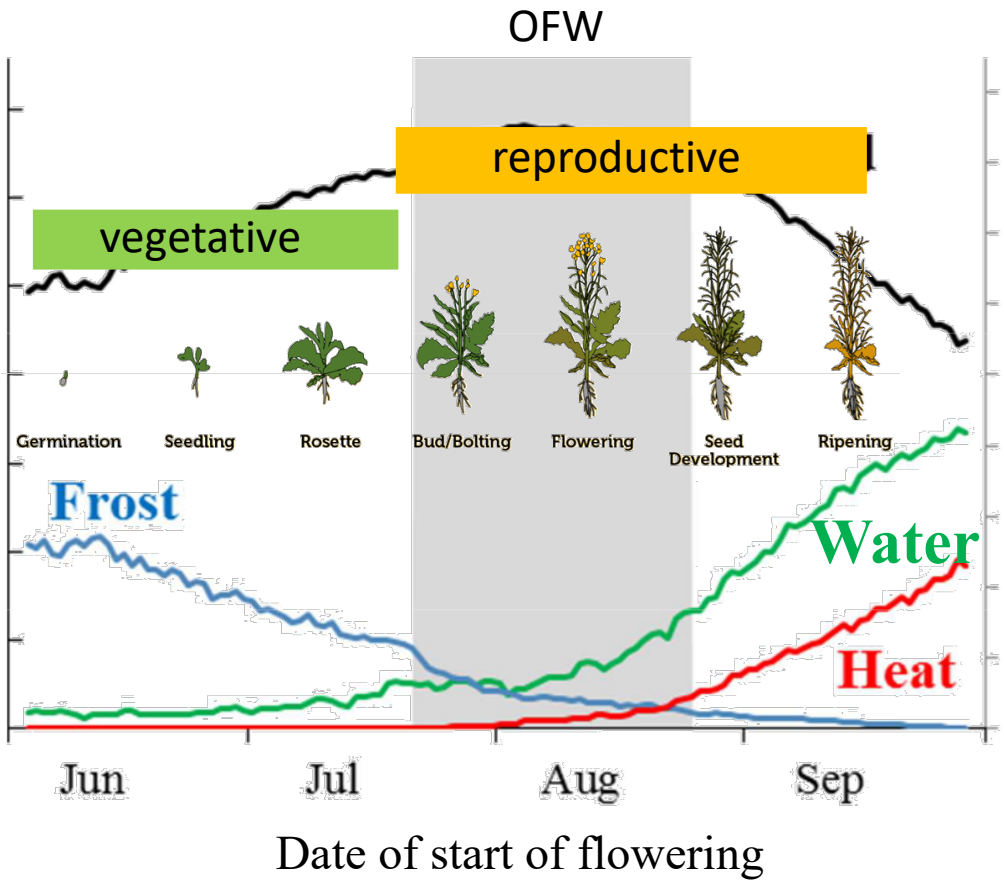
Optimising canola phenology



Lilley et al. (2017) Proceedings of the 18th Australian Society of Agronomy Conference

Genetics and environment drive phenology



Genome

- genetic effects
- GxG

Environment

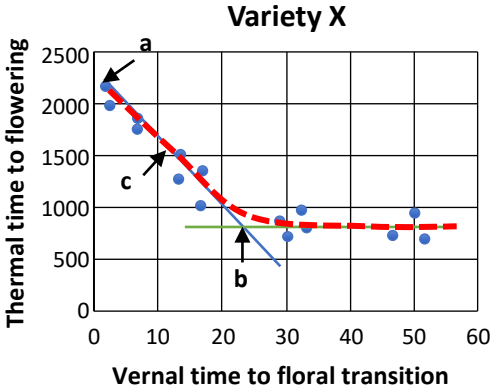
- plastic responses

Interactions

- GxE

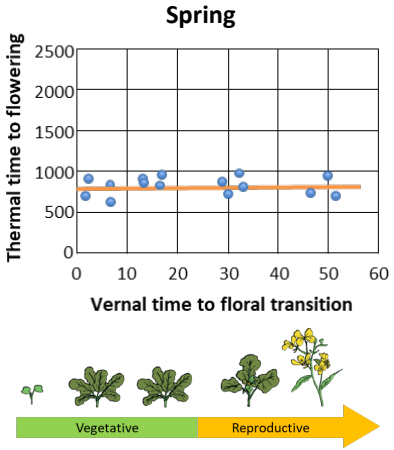
Capturing response to temperature

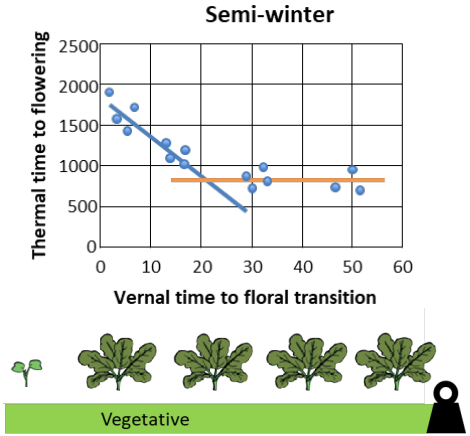
Example - phenology response multi-site data

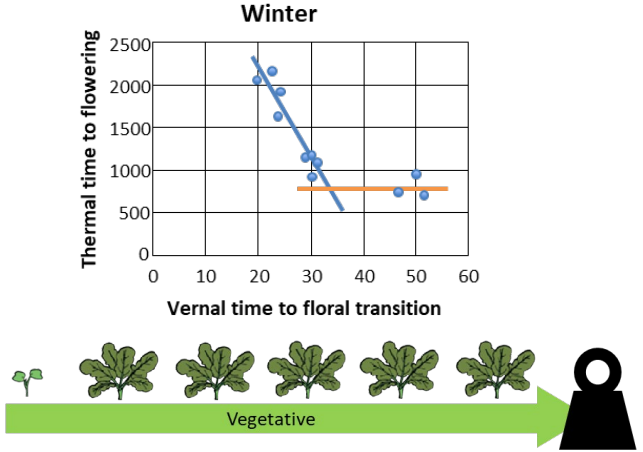


Parameters

a. TT to flower – no vern
b. Vern response saturated
c. Rate of response to vern







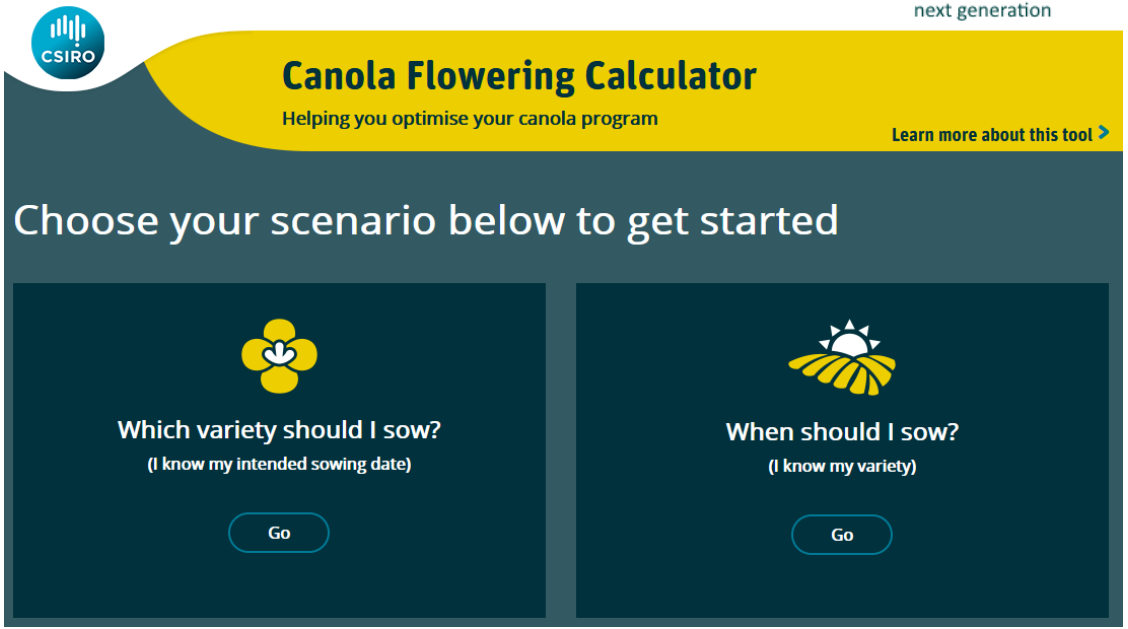
The current state

APSIM canola model simulates phenology

Does this accurately

But..
Phenology parameters must be estimated first

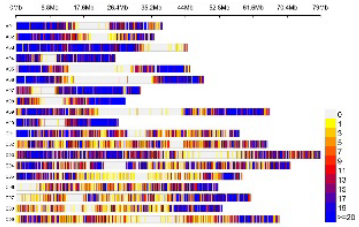
Compounded by rapid turn-over of canola varieties



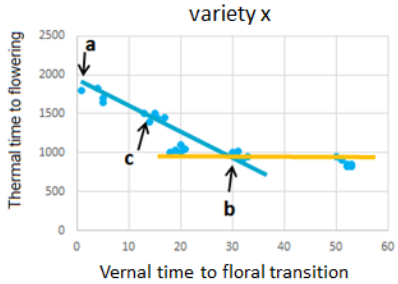
https://www.canolaflowering.com.au/

Combining crop modelling & genomics

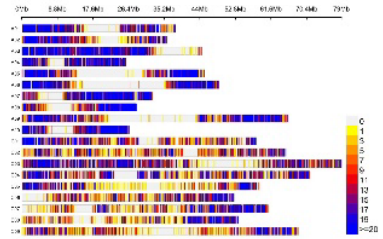
Genomic SNP data



Phenology parameters



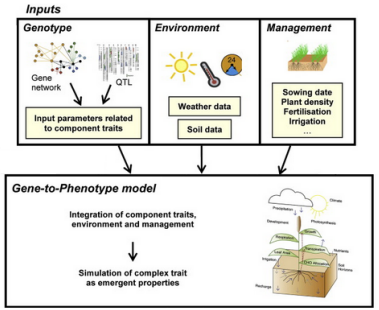
Genomic SNP data



APSIM parameter prediction model

Flowering time prediction

APSIM plant model



Adapted from Holzworth et al 2014, Environmental Modelling and Software

Integrated Analytics

Diversity panel
- Australian
- global

Experiments
- controlled env
- field trials

Environments
- thermal time
- vernal time

Phenotypes
- phenology
- parameters

'omics data
- SNP
- transcriptomes

MULTI-DATA ANALYSIS
Prediction
Feature detection

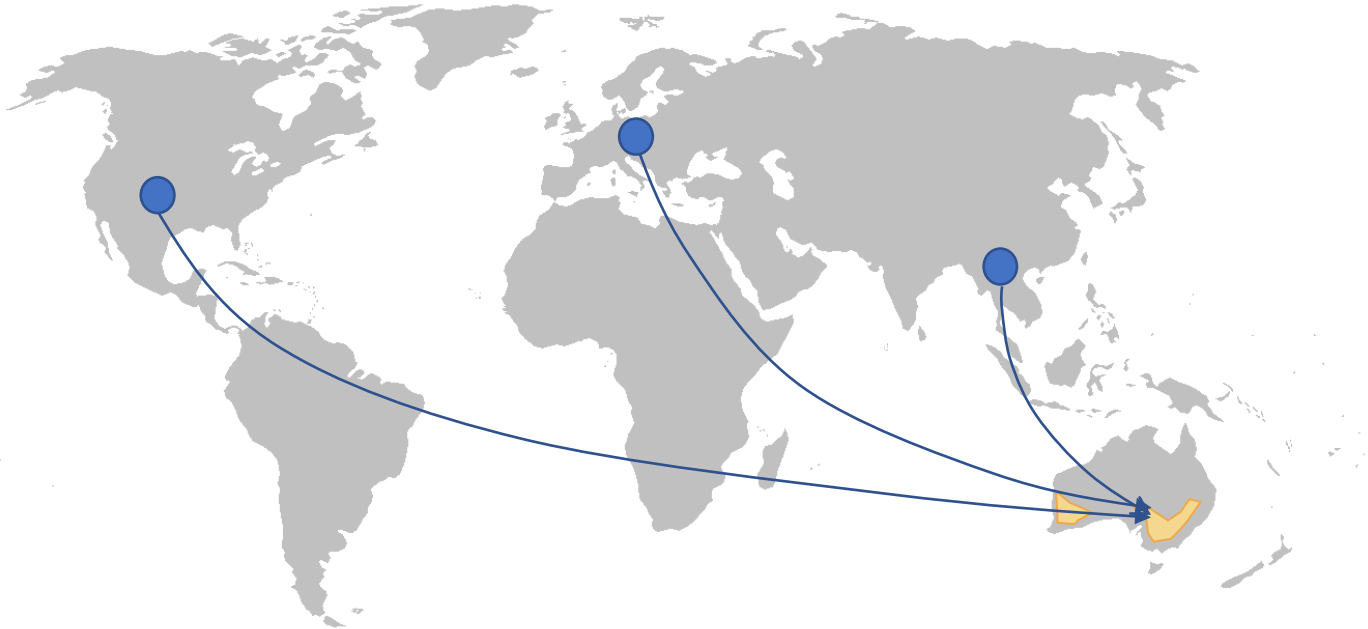
Features
- genes/alleles
- interactions
- pathways

Breeders

Genomic based phenology prediction tools

Growers & Breeders

Canola Diversity Panel

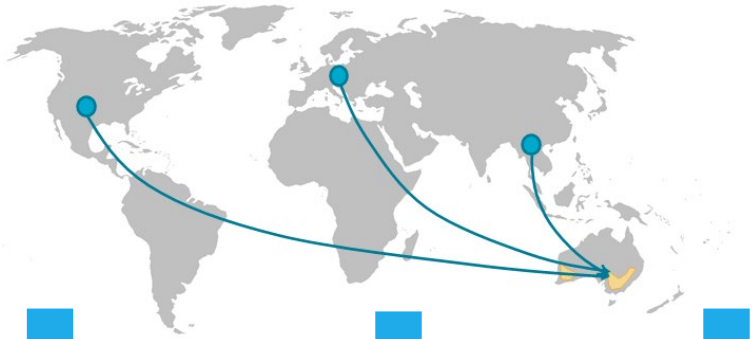


690 varieties

- Modern AUS
- Global:
  - BRAVO
  - ASSYST

Core set of 350 varieties underpinned data collection

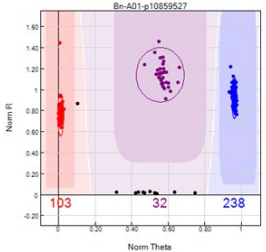
Canola Diversity Panel

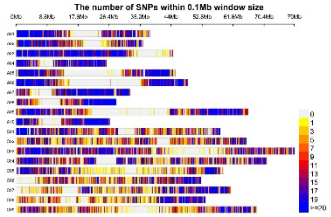


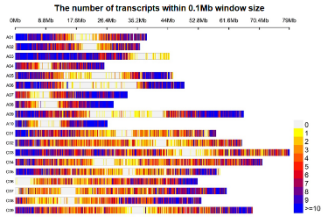
30K SNPs
Brassica array

300K
Trans-SNPs

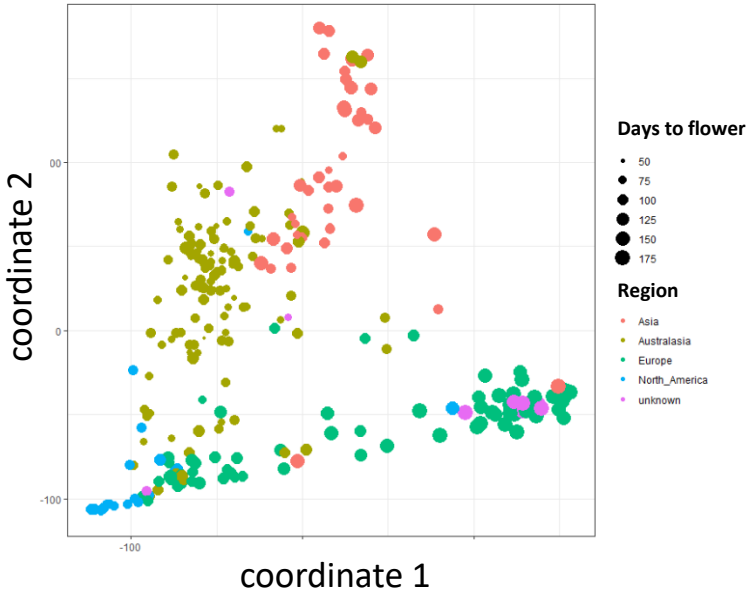
50K
transcripts



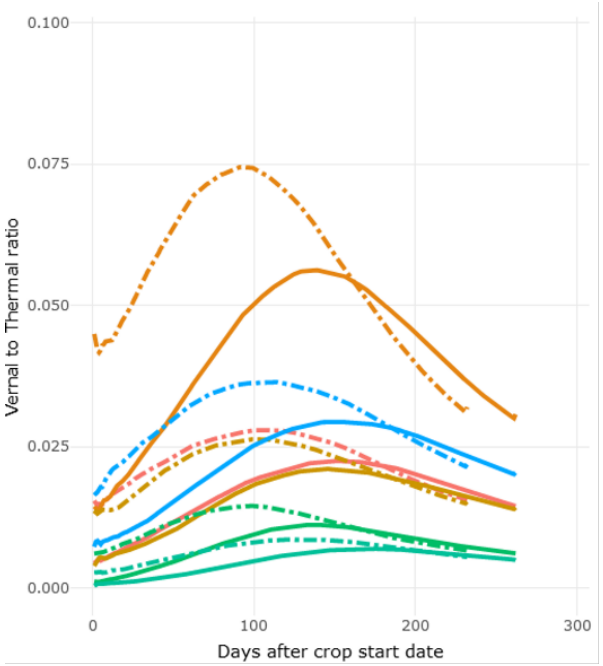


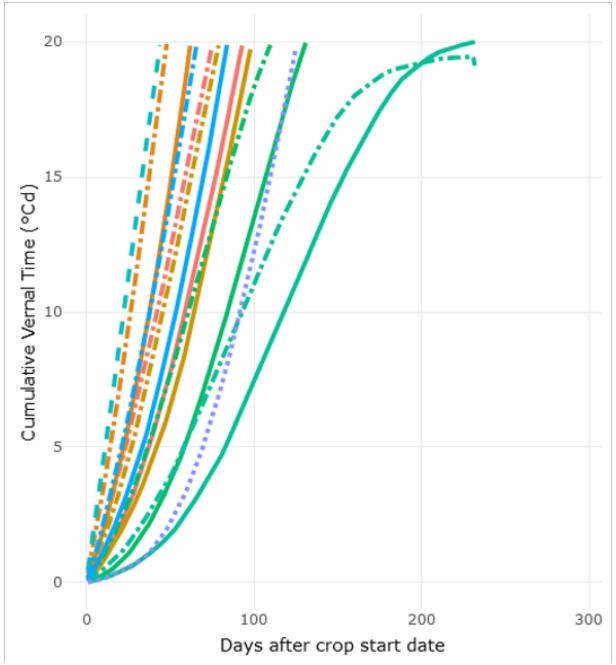


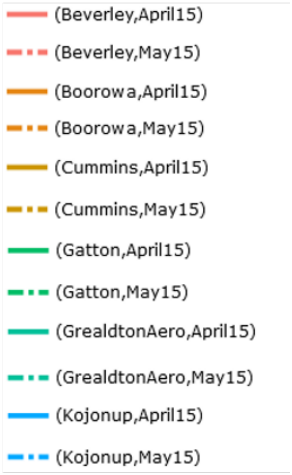
Genomic diversity captured



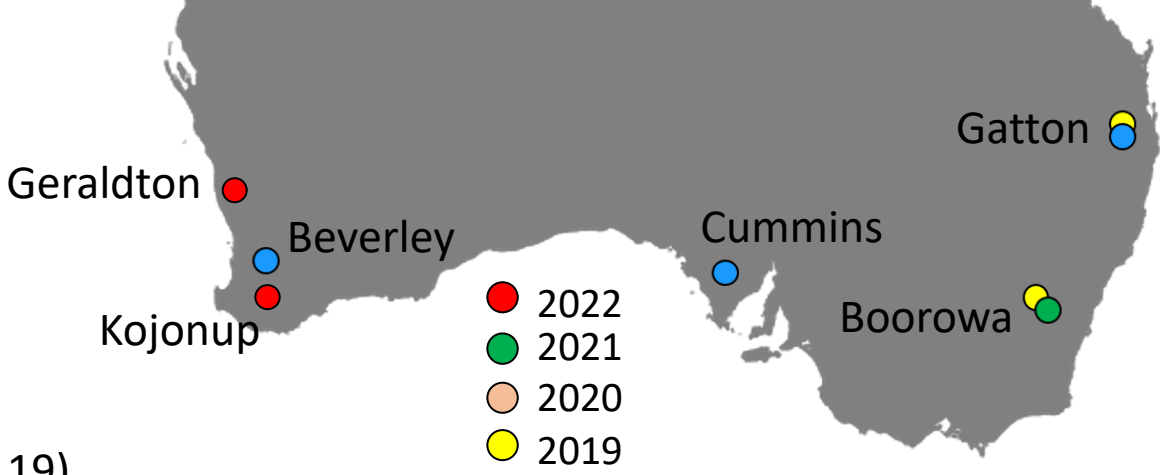
Selecting representative environments





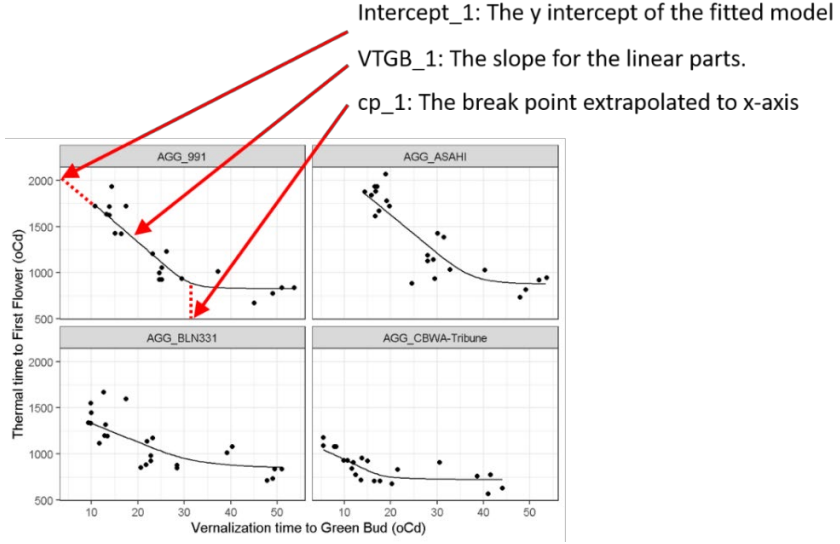


Field trials

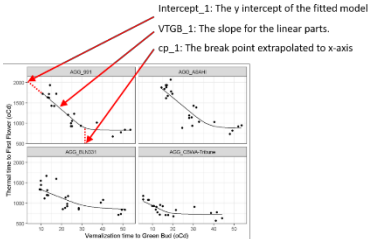


Phenology stages

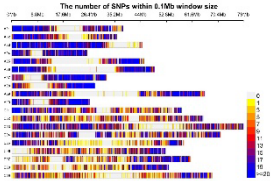
- Emergence (stage 9)
- leaf appearance (stages 10 – 19)
- bud visible (stage 51)
- first flower (stage 60)



Hybrid genomics-APSIM-NG model



APSIM parameter optimisation



SNP data

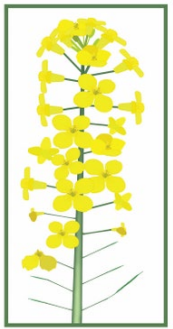
Genomic prediction
Random Forest

Genomic estimated APSIM parameters

Crop growth model
APSIM NG

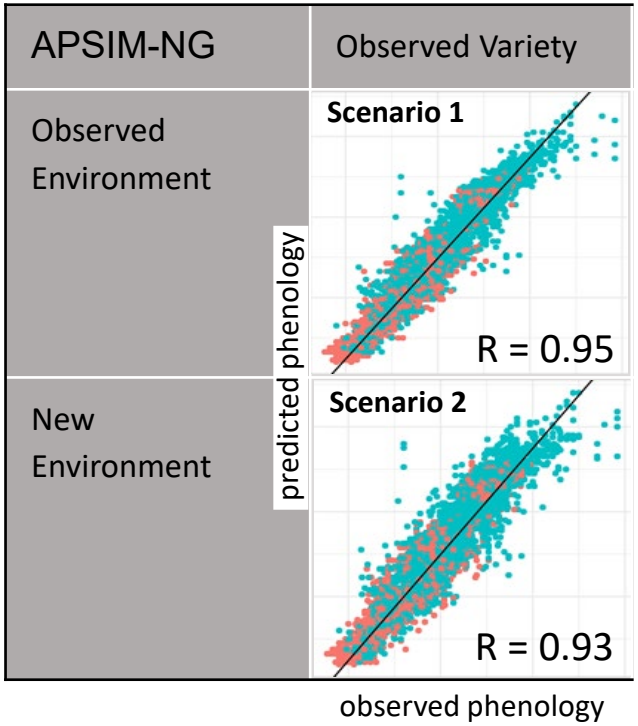
X-validation

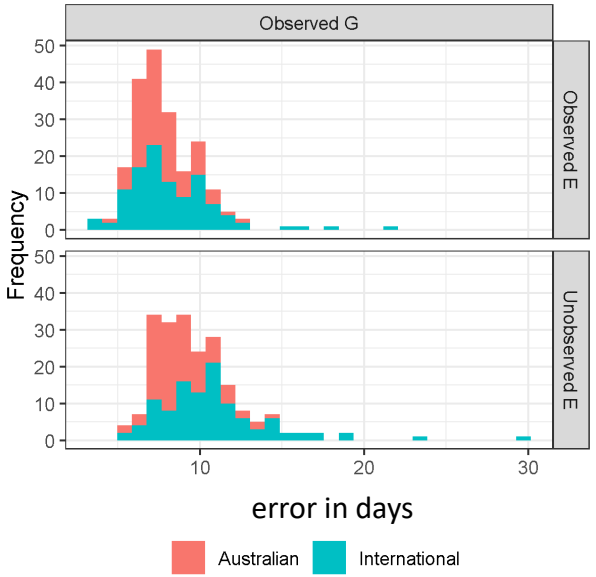
Observed phenology



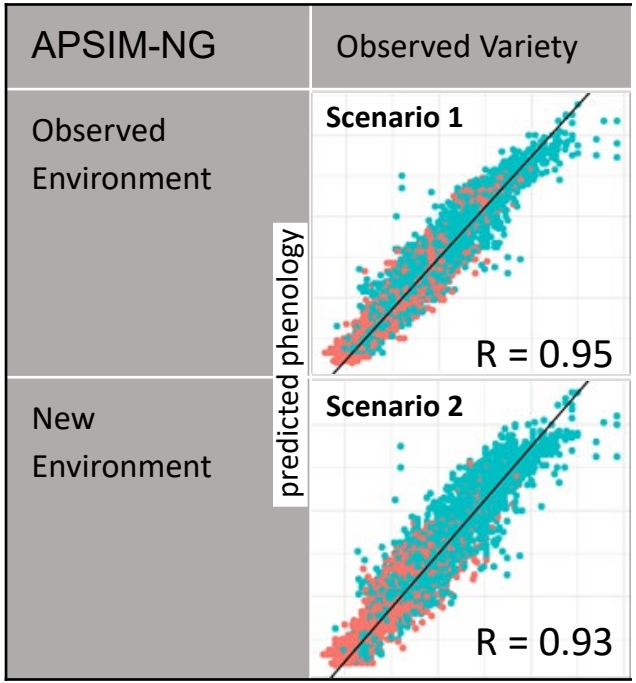
Flowering time prediction

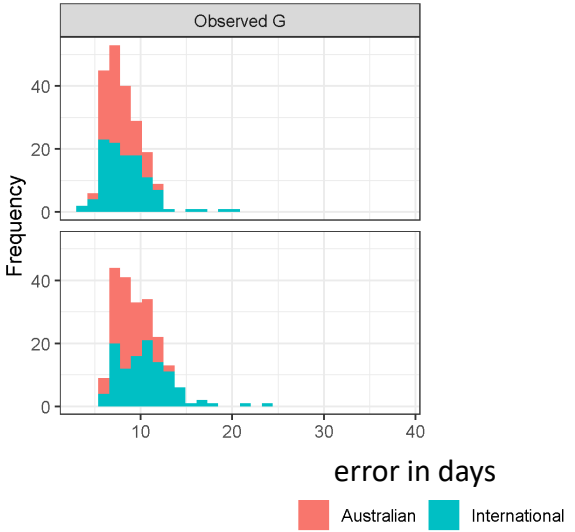
Performance of the current state



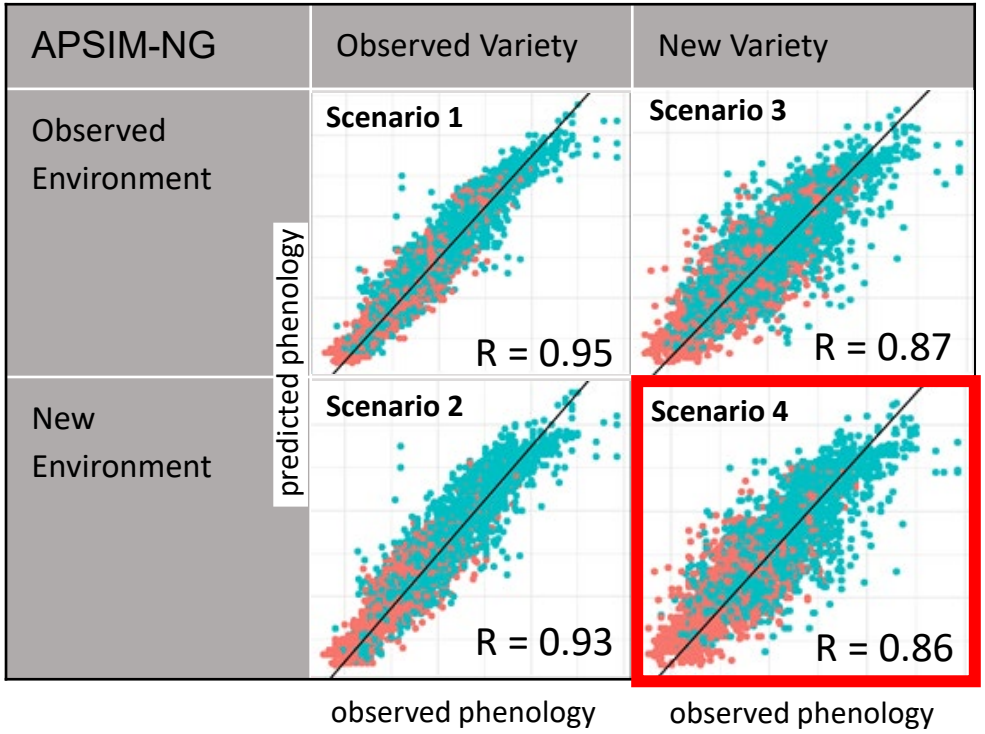


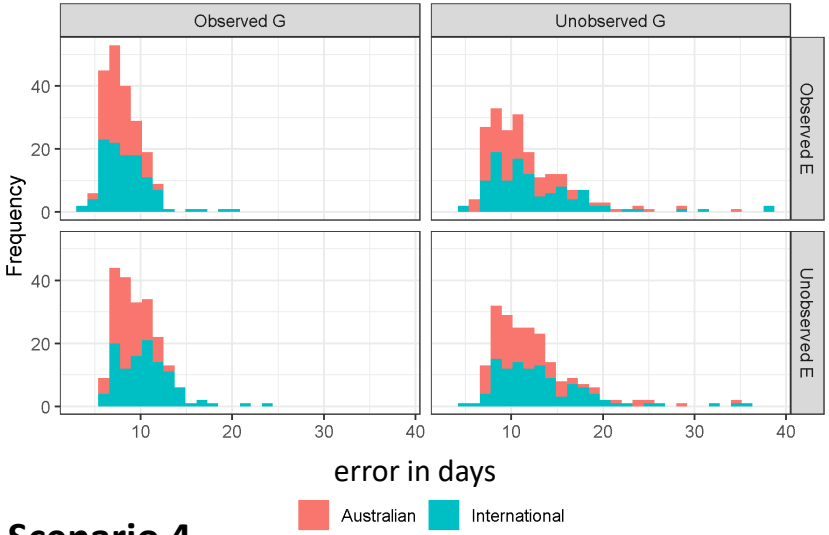
Performance of the genomic model





Performance of the genomic model





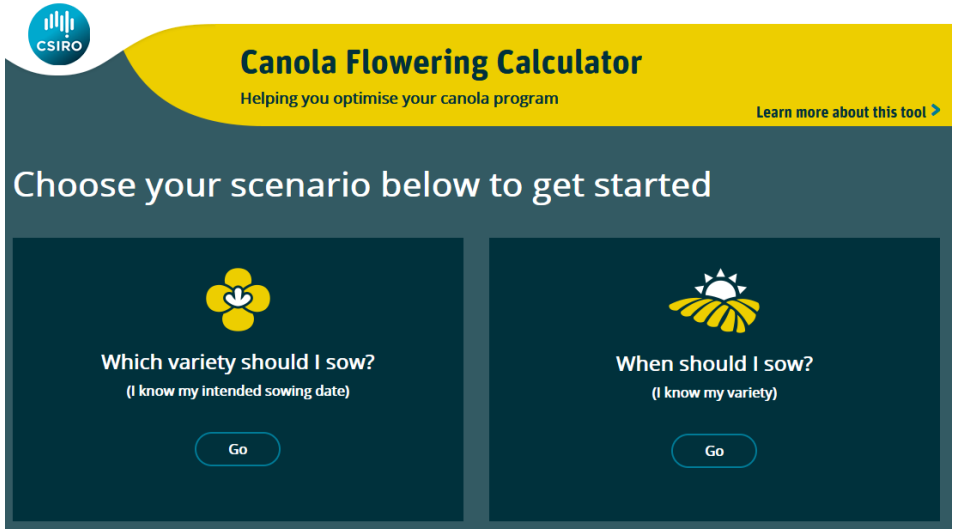
Scenario 4

R = 0.87 AUS and international varieties

Error within < 10 days on for AUS lines

CONCLUSION

- Genome-based phenology model performance highly encouraging
- More validation/refinement ongoing
- Updated phenology App on the way, including **wheat and barley**
- Use the current Canola Flowering Calculator!
- Breeders, consider providing access to your material for inclusion in the model.



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