

# **Genomic prediction of yield tolerance to drought in sunflower genetic resources**

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Presented by N. Langlade

## Context

### Genetic Resource Centre @ INRAE:

Marie-Claude Boniface and Camille Tapy with breeding companies

Effort to maintain and characterize => need to optimize usage

### Climatic Change :

→ need to identify lines tolerant to abiotic stresses

→ but very difficult : need to phenotype in numerous conditions and abiotic stresses are complex and interconnected

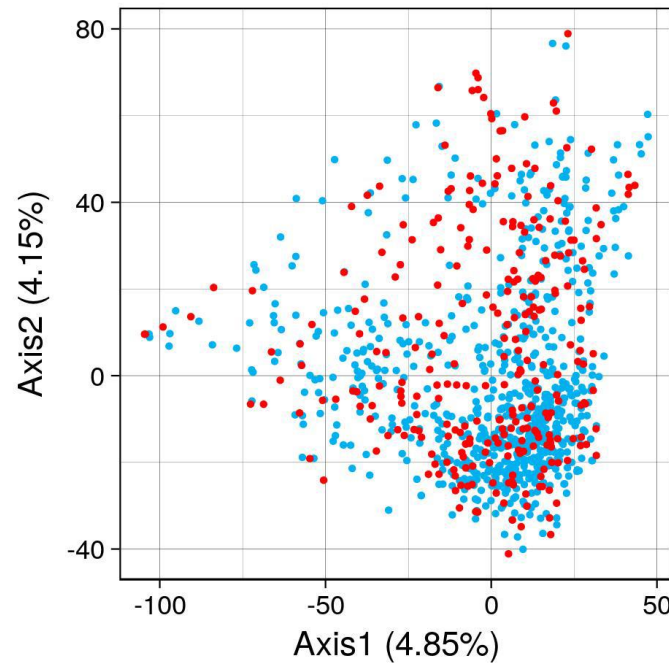
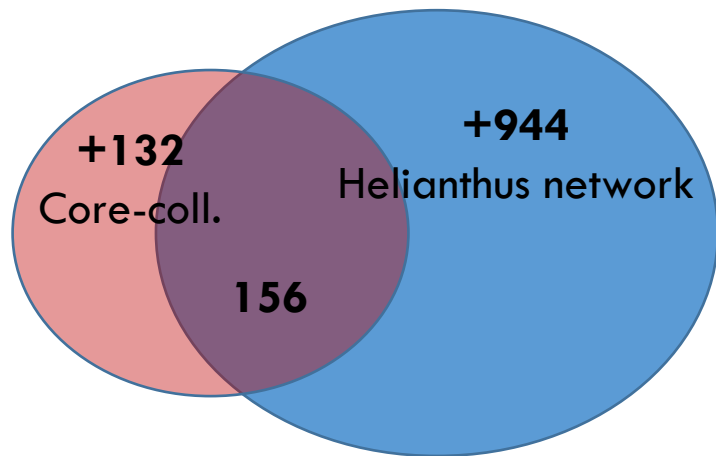
### Previous works

→ Plasticities to abiotic stresses for a core-collection are available ([Mangin et al. 2017 Plant Cell Environ.](#)).

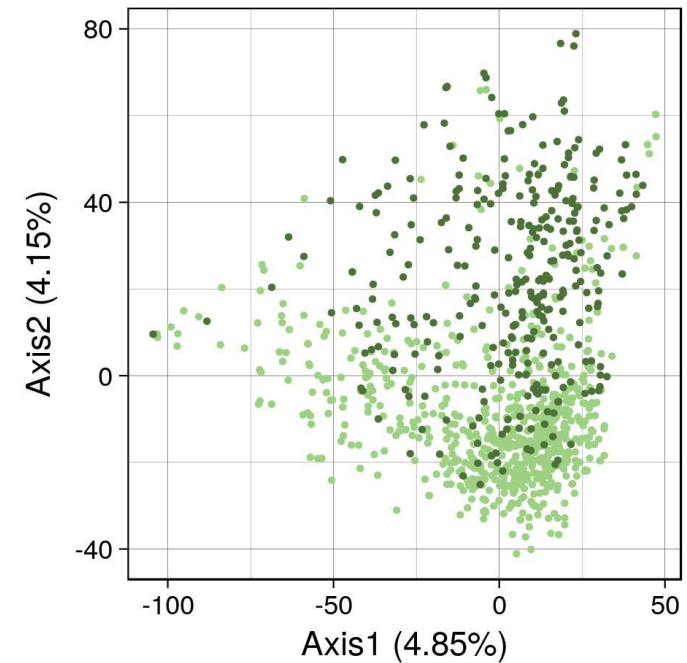
→ Genomic prediction tools are developed and applied on sunflower ([Mangin et al., 2017 Front in Plant Sc](#))

**➔ Can we predict plasticities to abiotic stresses for the GRC collection?**

# Genotyping Helianthus network collection



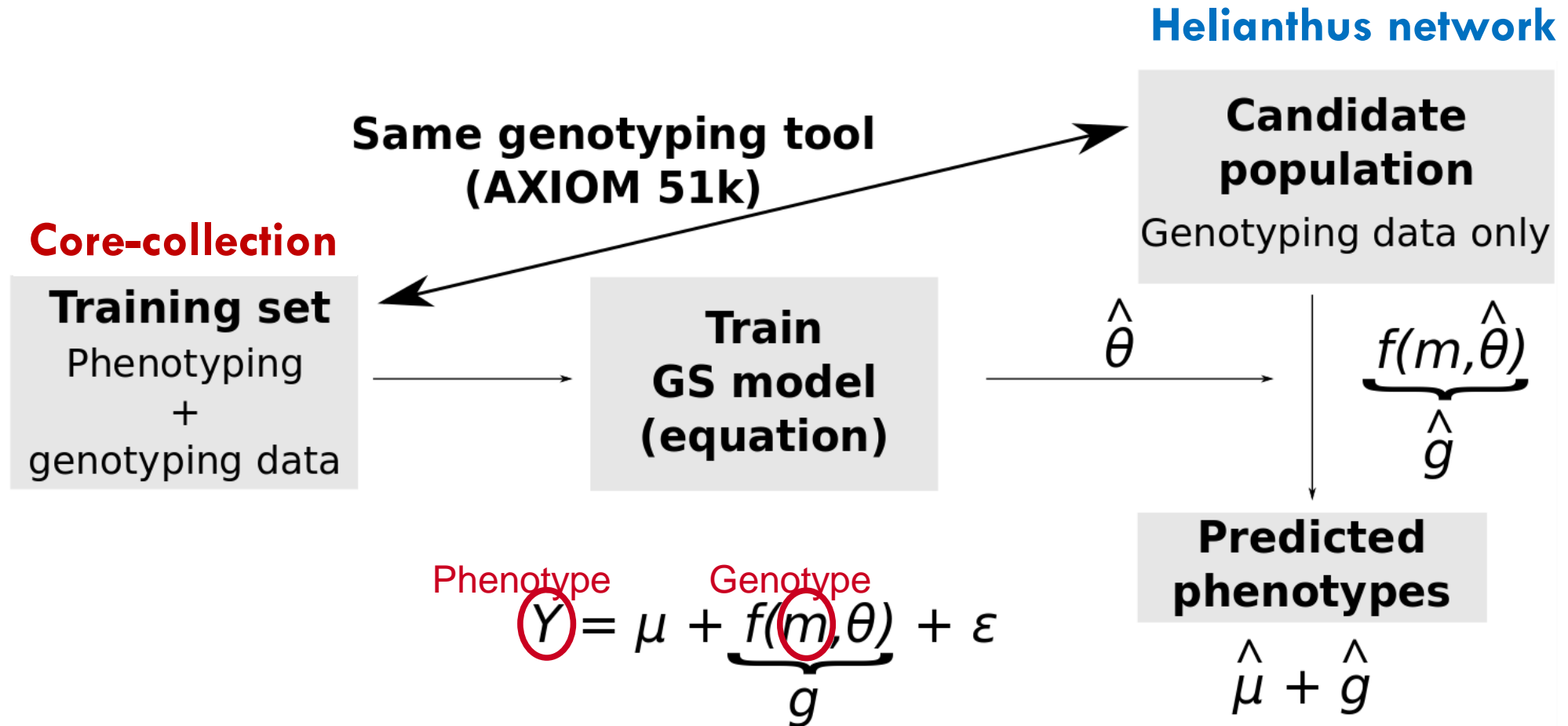
**Core-collection diversity**  
**Helianthus network diversity**



**R-lines**  
**B-lines**

**16 003 Markers High Quality**  
 Developed in Sunrise (-> S. Muños)

# Genomic prediction



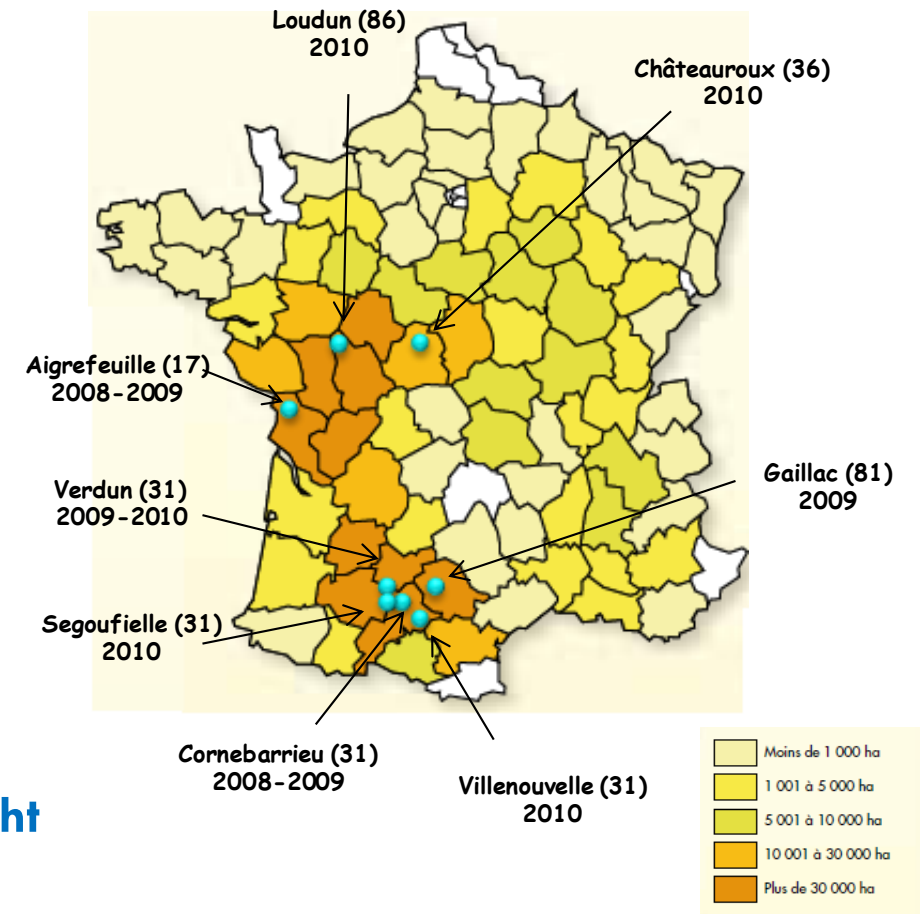
# Training Phenotypic data

- Oleosol project

- 126 restorer lines  
crossed to 2 different cmsPET1 testers
- 191 maintainer lines  
crossed to gms or cmsPEF1 tester
- 17 environments (year/site/condition)  
irrigated and non-irrigated
- 3 years: 2008 – 2010
- Conducted by private partners  
(Innolea, RAGT2n, Soltis, Syngenta)

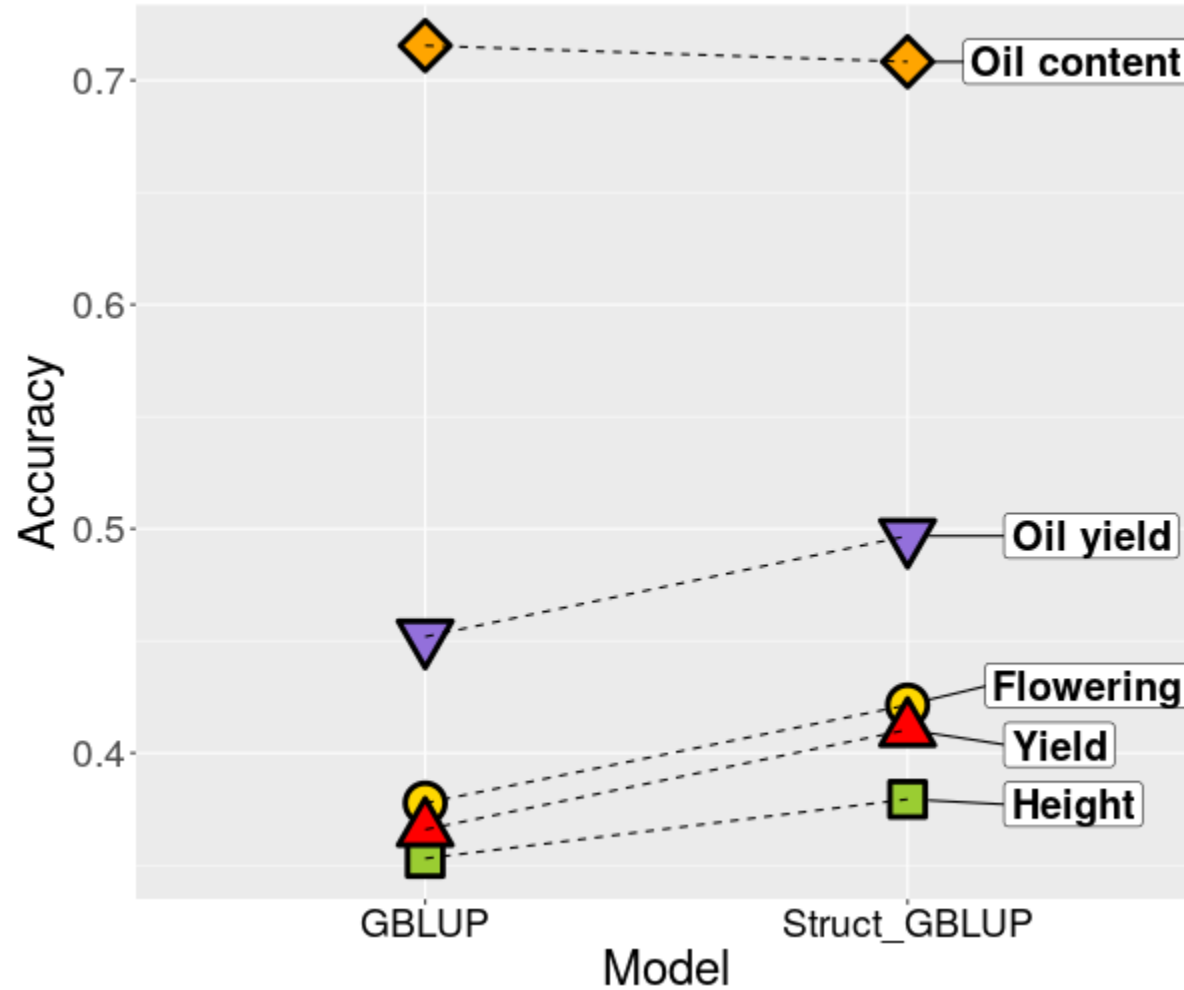
- Grain, Oil Content, Oil Yield, Flowering Time, Plant Height**

Mangin *et al.*, 2017 Plant Cell Environ



Sunflower acreage in France in 2011 (Source: ONIDOL)

## Prediction accuracy of breeding traits

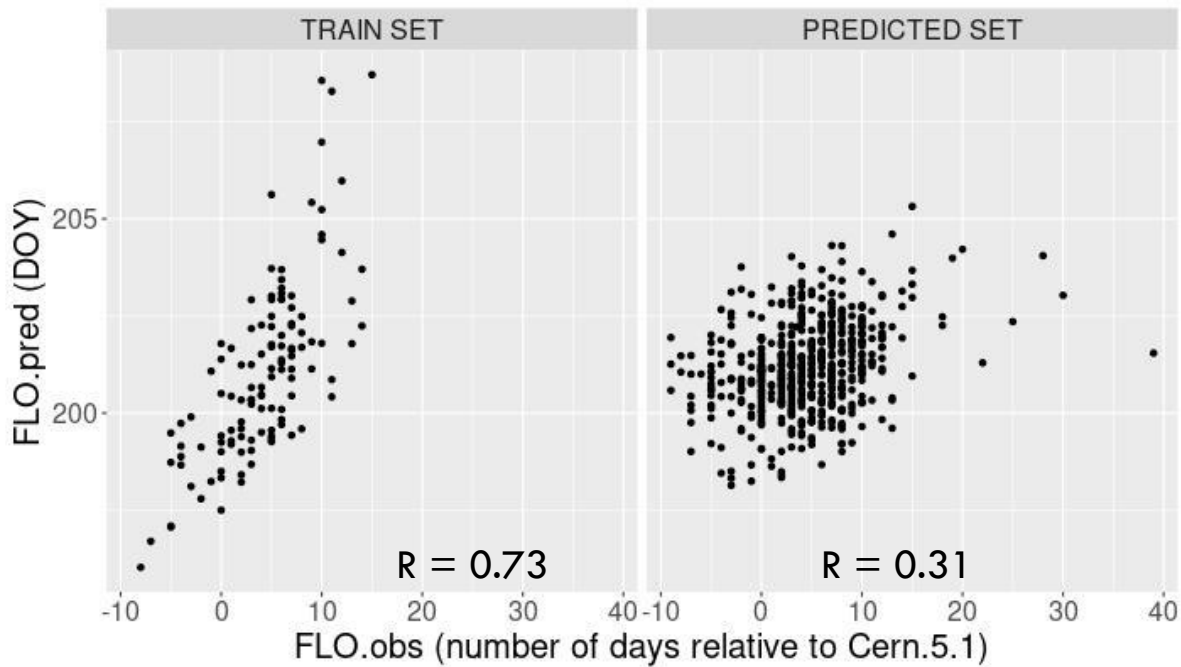


**Validation ?**

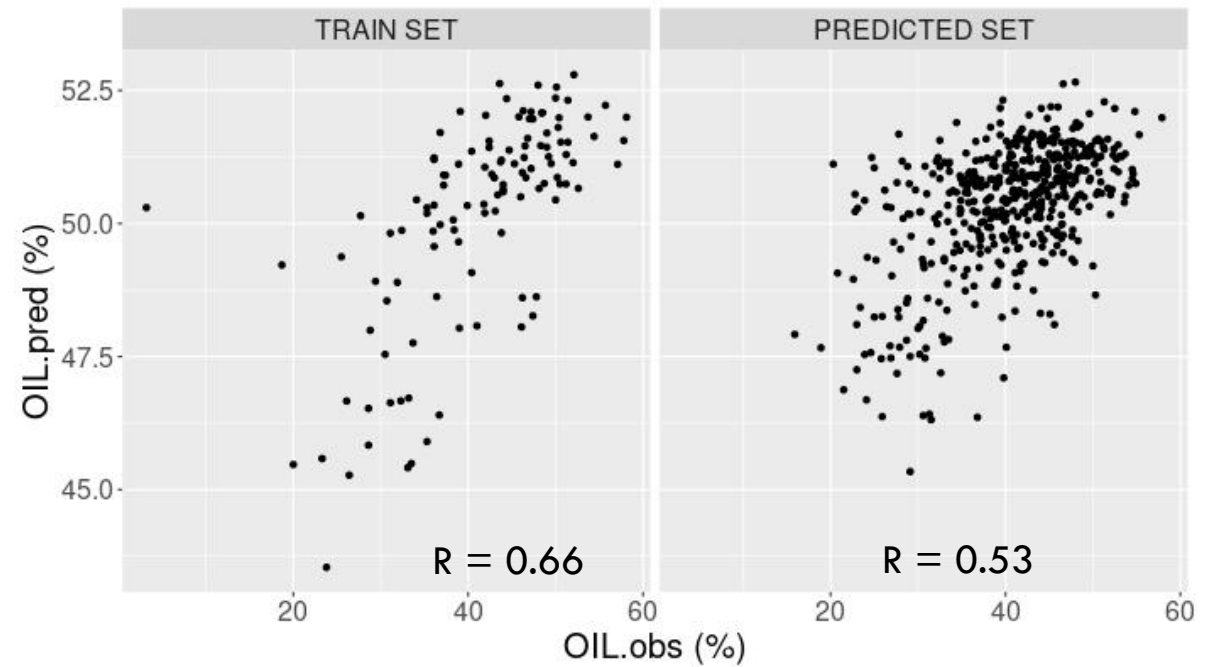
**Prediction of drought tolerance?**

# Experimental validation with historic data from GRC (Felicity Year)

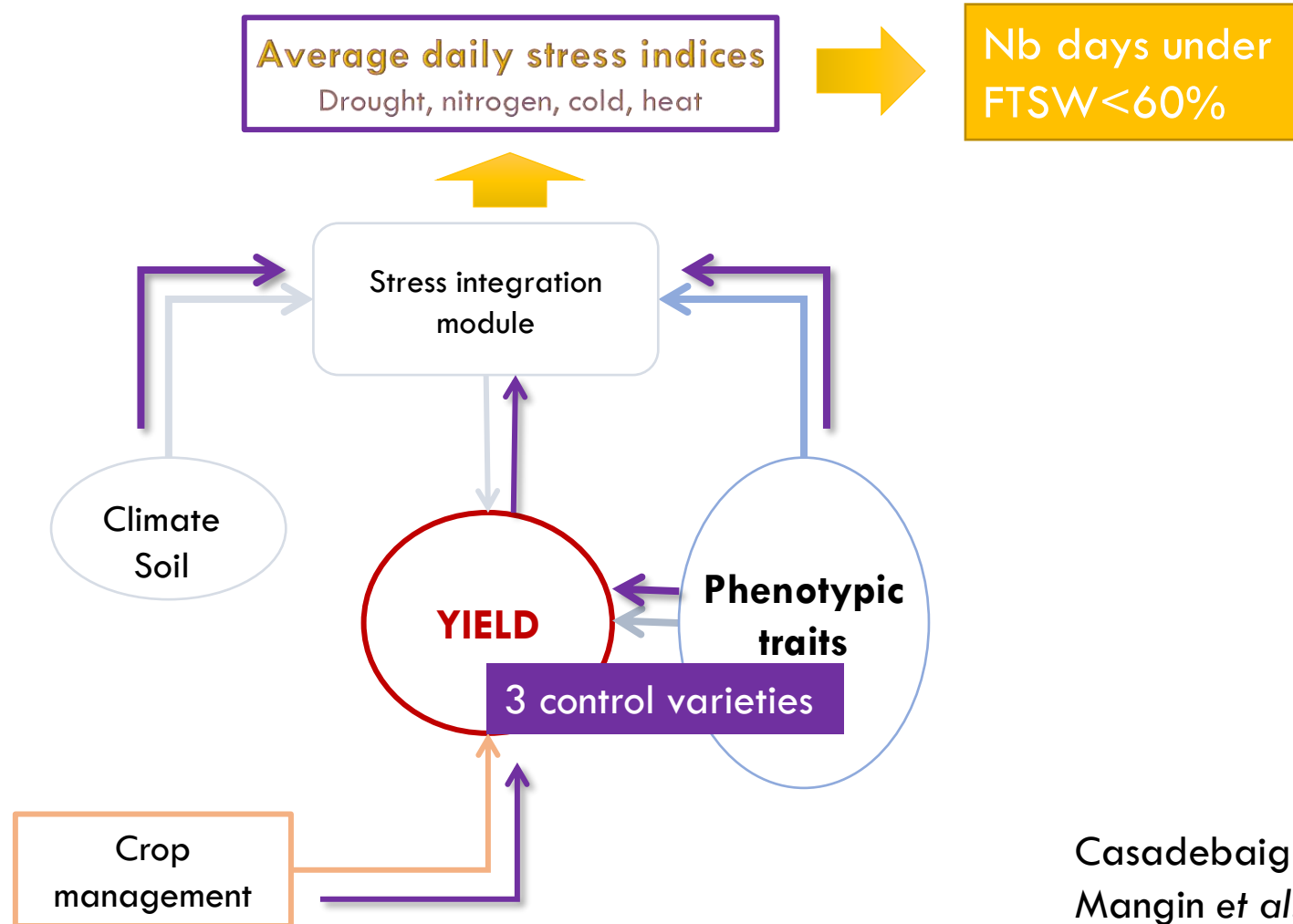
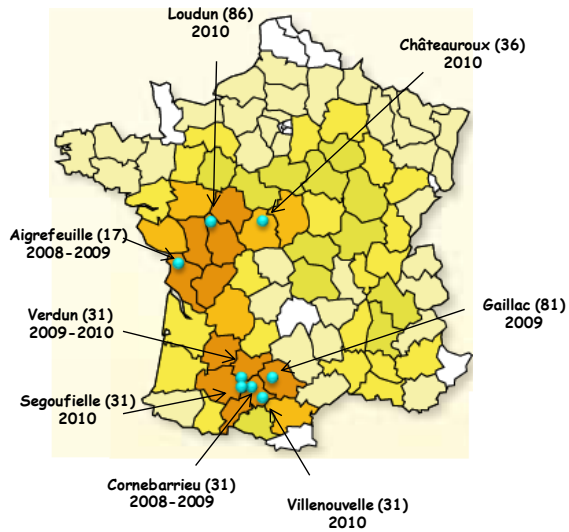
## Flowering time



## Oil content



# Yield plasticity calculation: step 1 Stress modeling



Casadebaig *et al.*, 2011  
 Mangin *et al.* 2017 PCE



# Yield plasticity calculation: step 2 validating stress impact

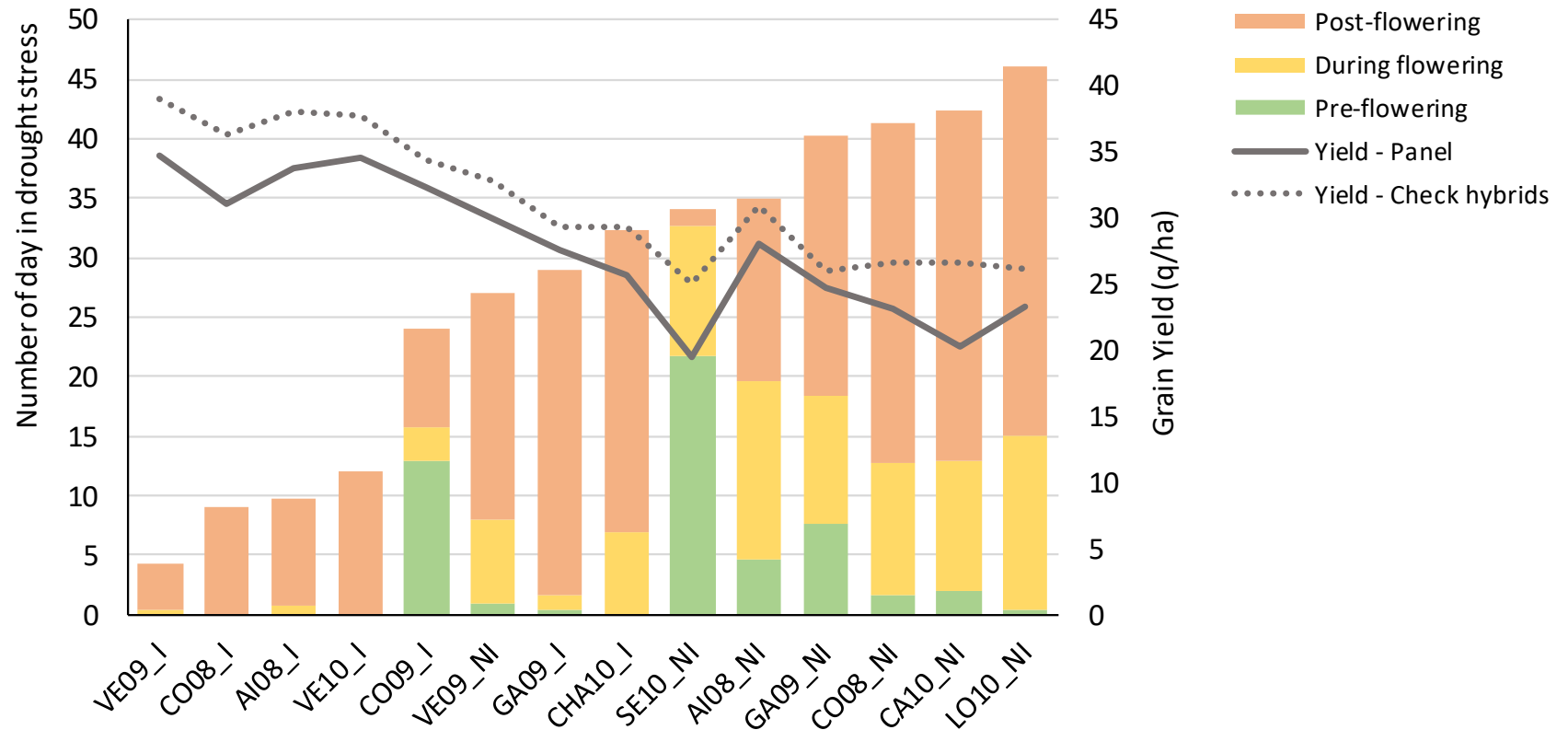
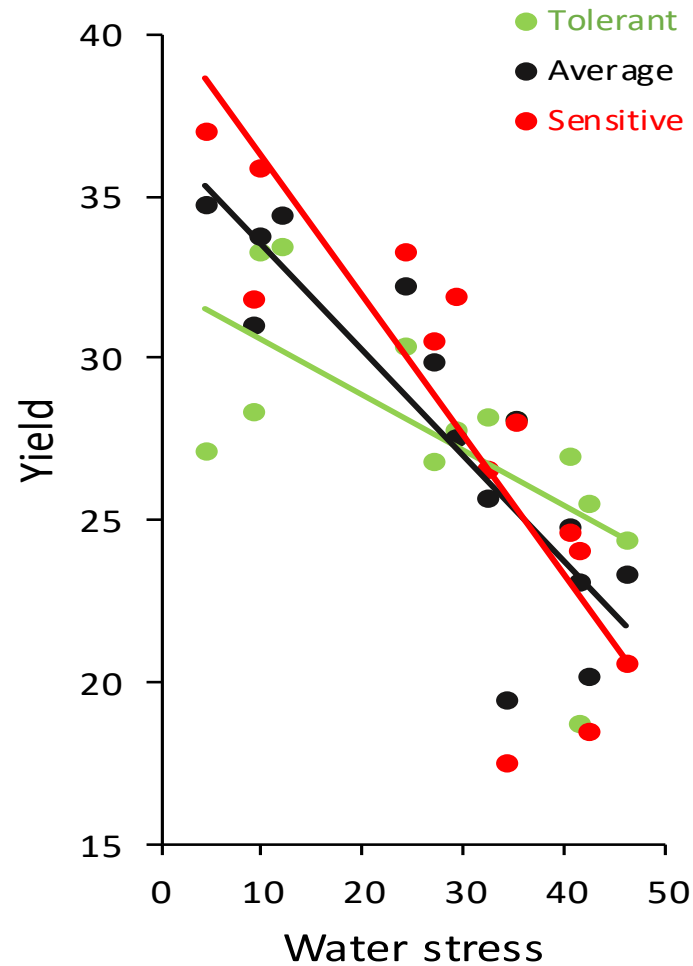


Figure: H. Duruflé

# Yield plasticity calculation: step 3 estimating plasticity

Tolerant  
 Average  
 Sensitive



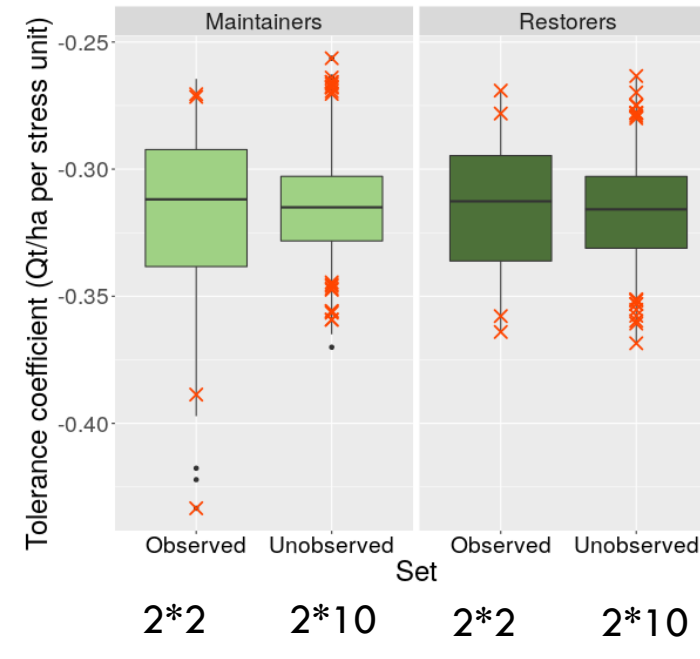
Plasticity to drought stress  
 288 lines

# Genomic prediction

## Accuracies

	B lines	R lines
Model using B lines only	0.41	
Model using B and R lines	0.38	0.12

Selection for validation



## Genotypes

- 24 B
- 24 R
- 8 observed
- 40 unobserved

cmsPEF1  
RHA274

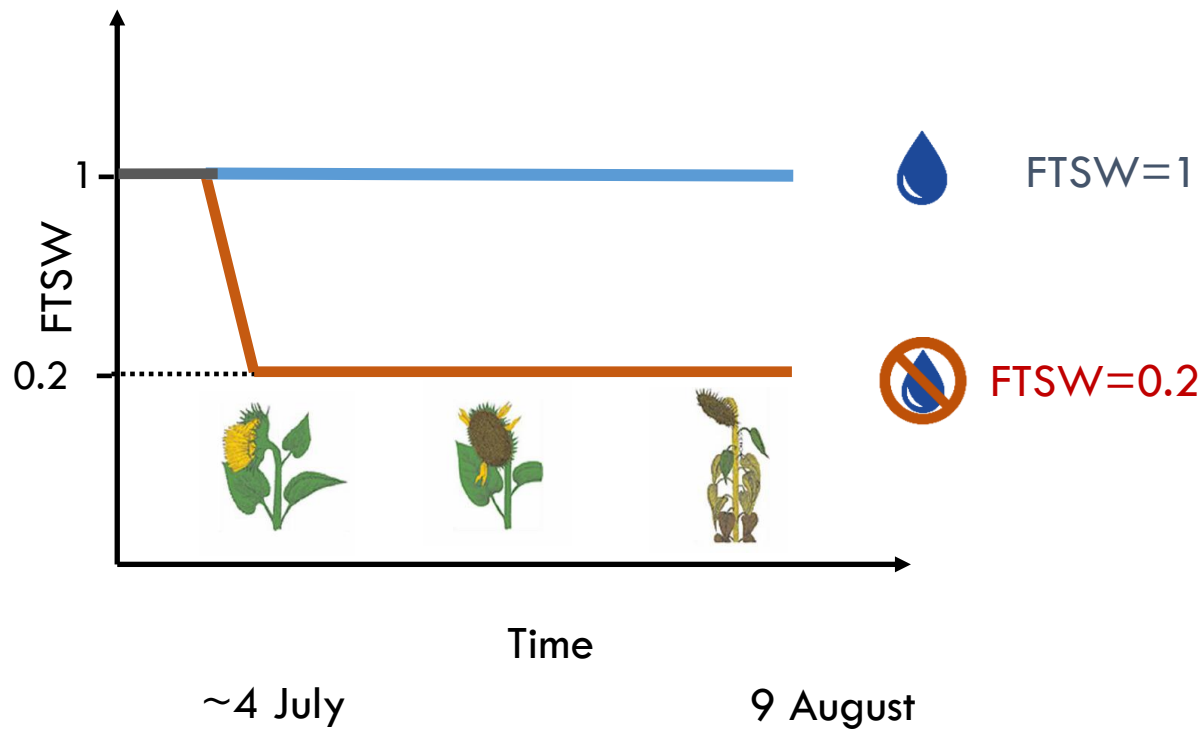
cmsPET1  
HA336



Soltis

**Heliaphen**

# Experimental validation: Heliaphen experiment

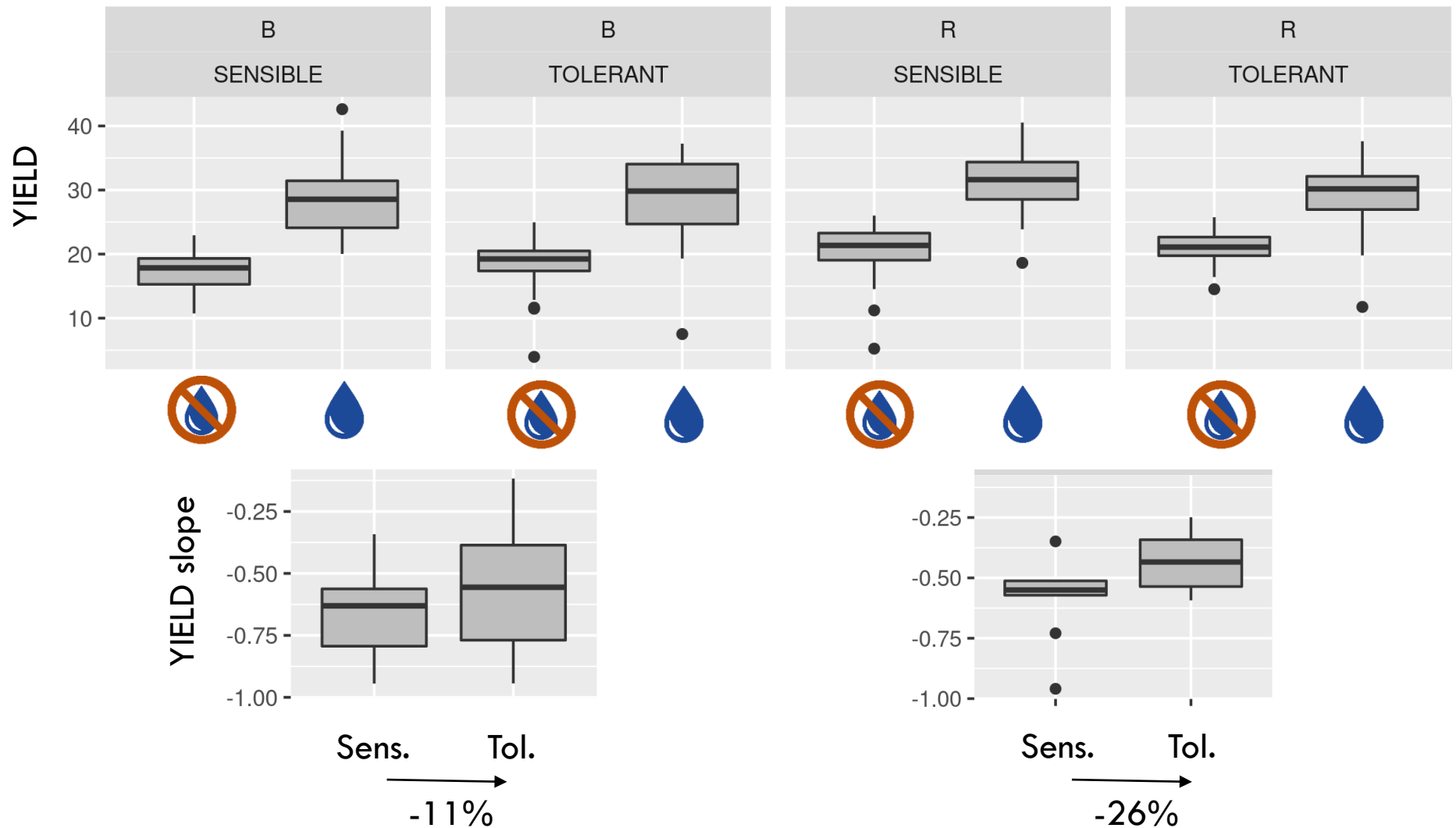


	Number
Total	368
Replicate	4
Treatment	2
Nb Genotype	46



# HeliaDiv2:

## Experimental validation: Heliaphen experiment YIELD



## Conclusions and perspectives

- Genomic prediction applied to GR
  - B-lines OK but R-lines accuracy dubious
  - FT and Oil content validated
  - Drought yield plasticity promising results but remains difficult
  
- New genotypic data
  - Genotyping of remaining 1 400 lines of GRC acquired in 2021
  
- New phenotypes
  - Growth, senescence  
 Using High Throughput Phenotyping
  - Quality
  - Disease resistance

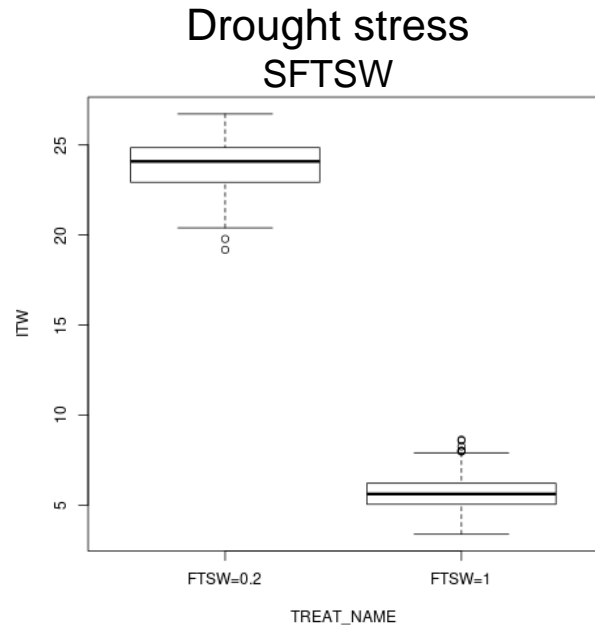


# Merci

- **Brigitte Mangin and Alexandra Duhnen**
- Nicolas Pouilly (genotyping)
- Nicolas Blanchet (Heliaphen phenotyping)
- GRC (Marie-Claude Boniface, Camille Tapy, Felicity Vear)
- Genetic material with the help of Soltis (Muriel Archipiano and Benoit Bleys)

# HeliaDiv2:

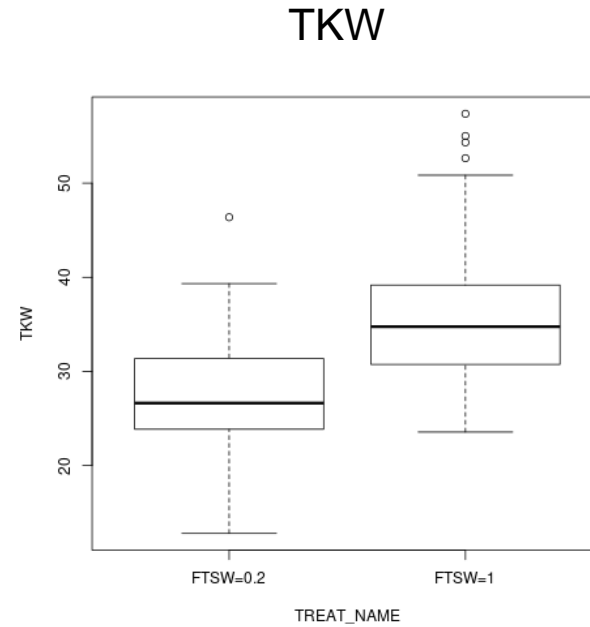
## Experimental validation: Heliaphen experiment



FTSW=0.2



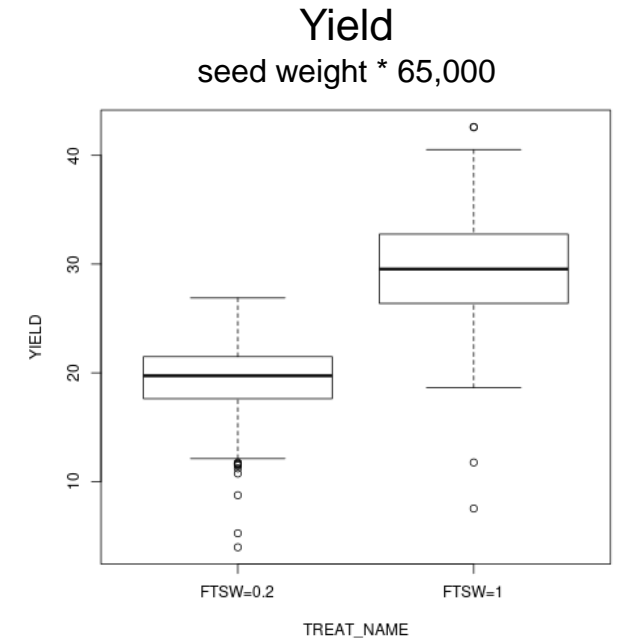
FTSW=1



FTSW=0.2



FTSW=1



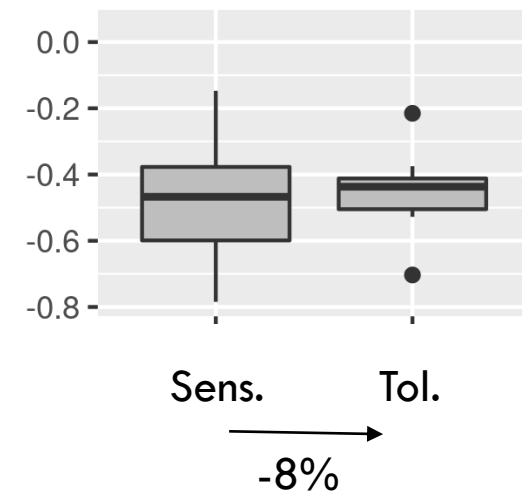
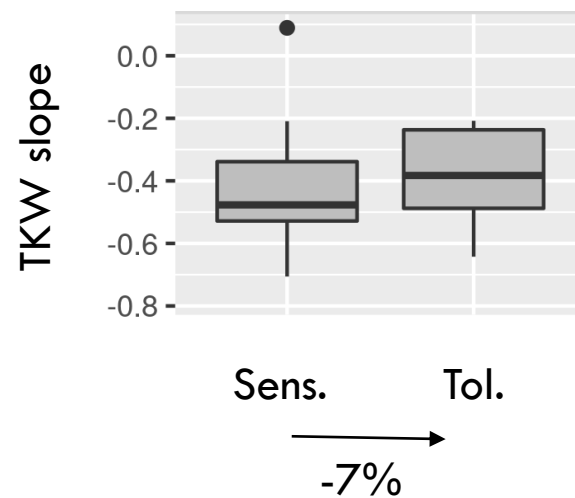
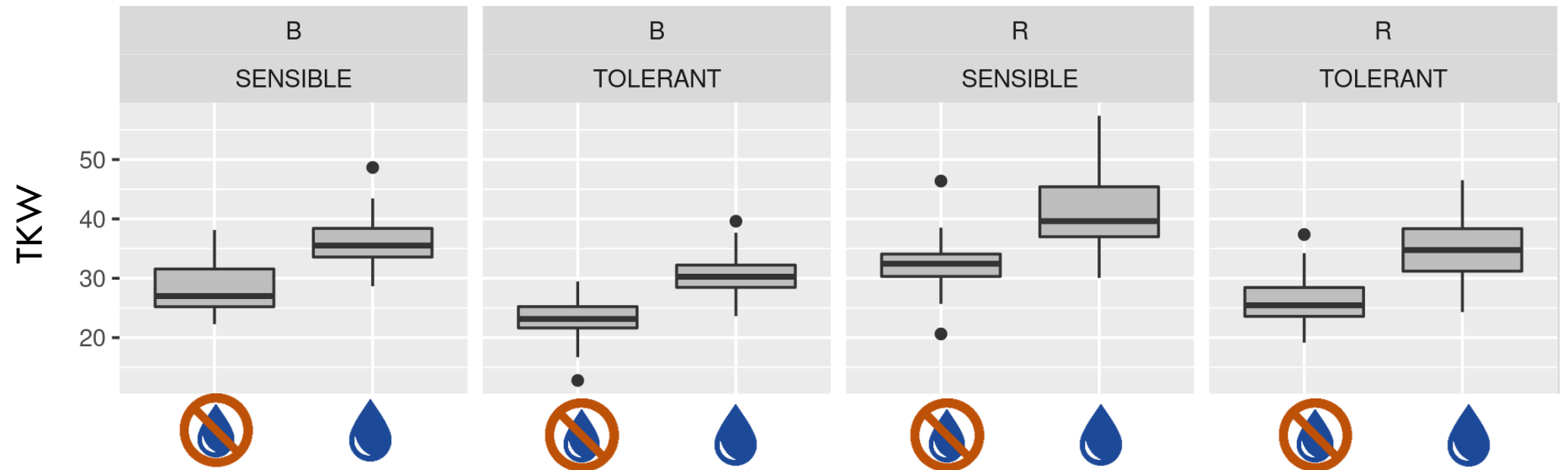
FTSW=0.2



FTSW=1

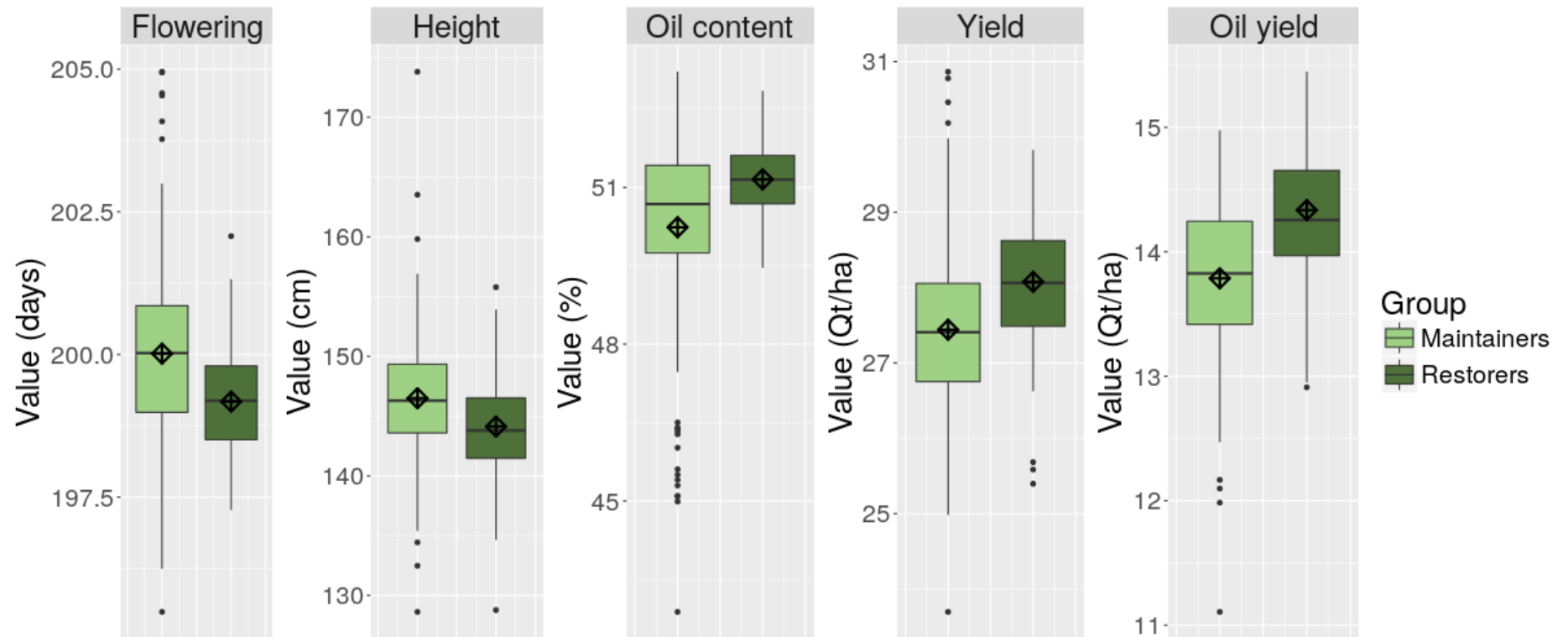


# HeliaDiv2: Experimental validation: Heliaphen experiment TKW



Unobserved genotypes

# HeliaDiv2 : Phenotypic data



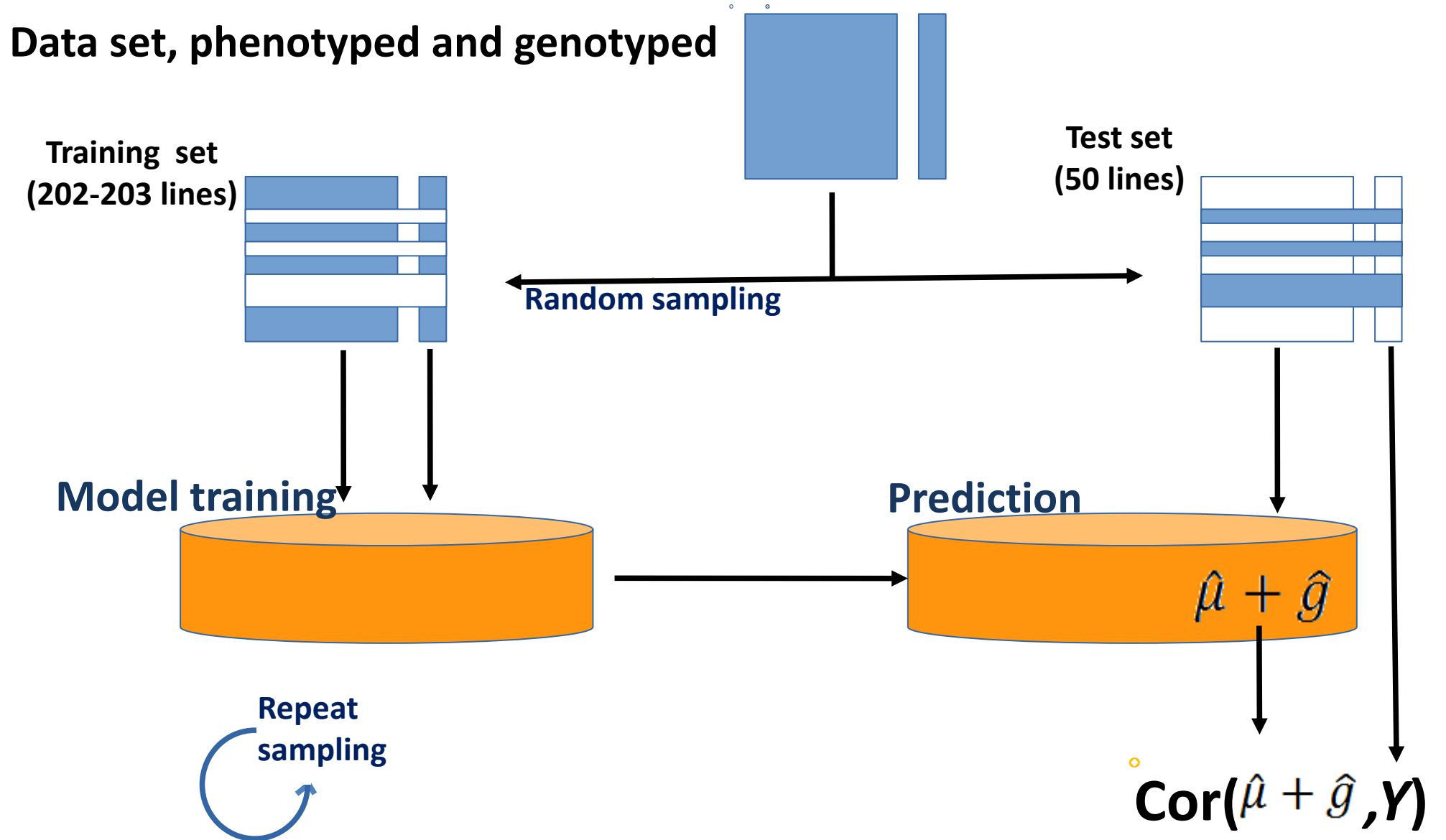
Average over >6 environments

Difference B/R might be due to different testers

# HeliaDiv2

## Genomic prediction

- 11 phenotypes
  - Grain yield
  - Oil yield
  - Oil content
  - Plant height
  - Flowering time
  - Plasticity
    - Grain yield for drought stress
    - ... cold stress
    - ... nutrient stress
    - Oil yield ...



# HeliaDiv2 : Prediction accuracy

Test training set

Trait	Group	Accuracy
Flowering	B	0.46
Flowering	R	0.01
Height	B	0.37
Height	R	-0.07
Oil content	B	0.69
Oil content	R	0.01
Yield	B	0.55
Yield	R	0.30
Oil yield	B	0.42
Oil yield	R	0.18

Trait	Training set	Environment set	Predicted set	
			B	R
Flowering	B	MET	0.51	
Flowering	B	S1	0.54	
Flowering	BR	MET	0.51	0.12
Flowering	BR	S1	0.53	0.16
Height	B	MET	0.29	
Height	B	S1	0.34	
Height	BR	MET	0.37	0.36
Height	BR	S1	0.41	0.22
Oil content	B	MET	0.75	
Oil content	B	S1	0.70	
Oil content	BR	MET	0.75	0.27
Oil content	BR	S1	0.72	0.18
Yield	B	MET	0.47	
Yield	B	S1	0.53	
Yield	BR	MET	0.43	0.11
Yield	BR	S1	0.52	0.23
Yield tolerance to drought	B	MET	0.41	
Yield tolerance to drought	BR	MET	0.38	0.12
Oil yield	B	MET	0.47	
Oil yield	B	S1	0.37	
Oil yield	BR	MET	0.44	0.06
Oil yield	BR	S1	0.31	0.16

## HeliaDiv2: Experimental validation

- Available data from Sunflower GRC (Felicity Year)
  - Flowering time
  - Oil content
- New experiment on Heliaphen
  - Grain yield plasticity for drought stress