

**2004-2009**

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**Stable isotope  
analysis**

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# Why breed for water use efficiency (WUE)?

Globally crop yields have increased progressively, one of the key reasons is the increase in the area of irrigated land.

This cannot continue:

- water is being used unsustainably
- competition for water is increasing

In the future crop production will need to be sustained not by using more water but by increasing the productivity of water

$WUE = \text{yield} / \text{water input}$

# Approaches

1. Identification of QTL in *B. oleracea* A x G and N x G DH populations
2. Phenotyping of A x G substitution lines
3. Association mapping in *B. oleracea* diversity sets
4. Parallel studies in *Arabidopsis*, then comparative analysis

# Traits

WUE = crop yield/water input  
= biomass/transpiration  
= CO<sub>2</sub> assimilation/stomatal conductance

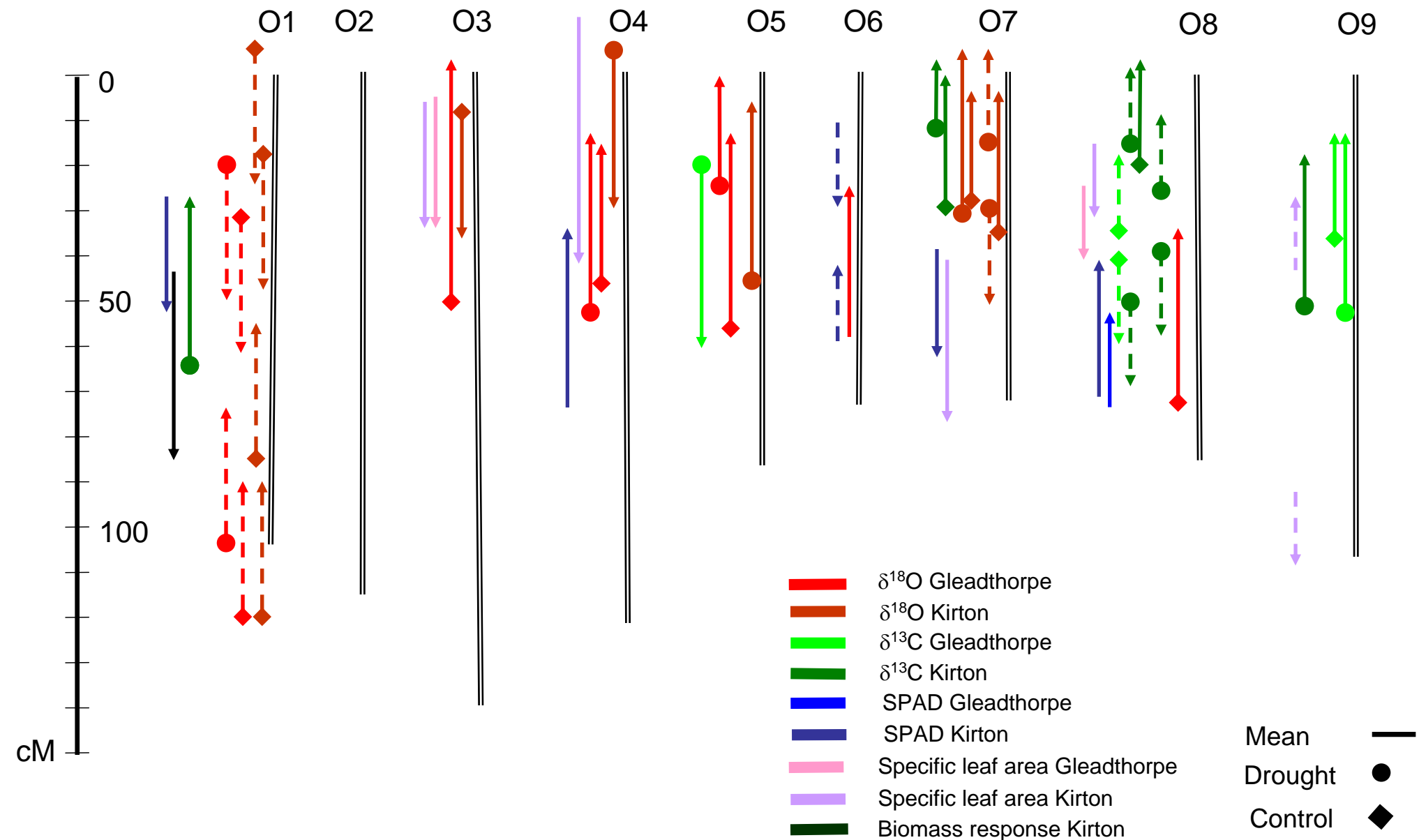
- Biomass response to irrigation
- $\delta^{13}\text{C}$  (positive correlation with leaf water-use efficiency)
- $\delta^{18}\text{O}$  (negative correlation with transpiration)
- IRGA
- Photosynthetic capacity (leaf thickness and SPAD)

# 1. Identification of QTL in *B. oleracea* A x G populations



Spanish tunnels - Kirton

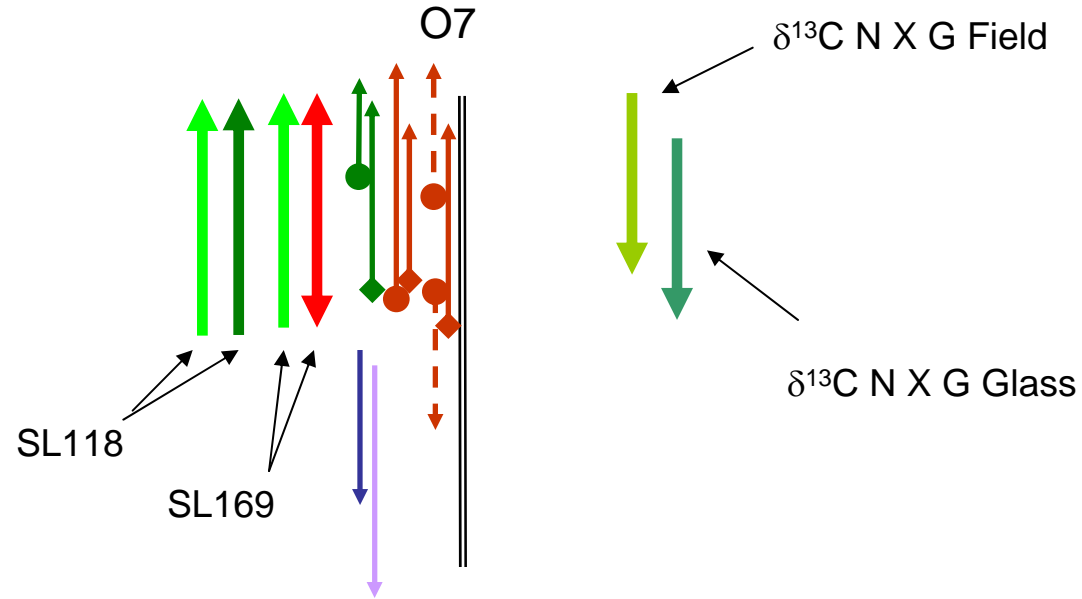
# QTL for WUE traits in A x G DH population



# Conclusions from *B. oleracea* Linkage Group 7

Low transpiration colocalises with high WUE QTL at Kitron.

SL lines and N x G DH QTL support WUE QTL at both sites.



A x G – up arrow *A12* is positive allele  
 N x G – up arrow *Nedcha* is positive allele

- █  $\delta^{18}\text{O}$  Gleadthorpe
- █  $\delta^{18}\text{O}$  Kirton
- █  $\delta^{13}\text{C}$  Gleadthorpe
- █  $\delta^{13}\text{C}$  Kirton
- █ SPAD Gleadthorpe
- █ SPAD Kirton
- █ Specific leaf area Gleadthorpe
- █ Specific leaf area Kirton
- █ Biomass response Kirton

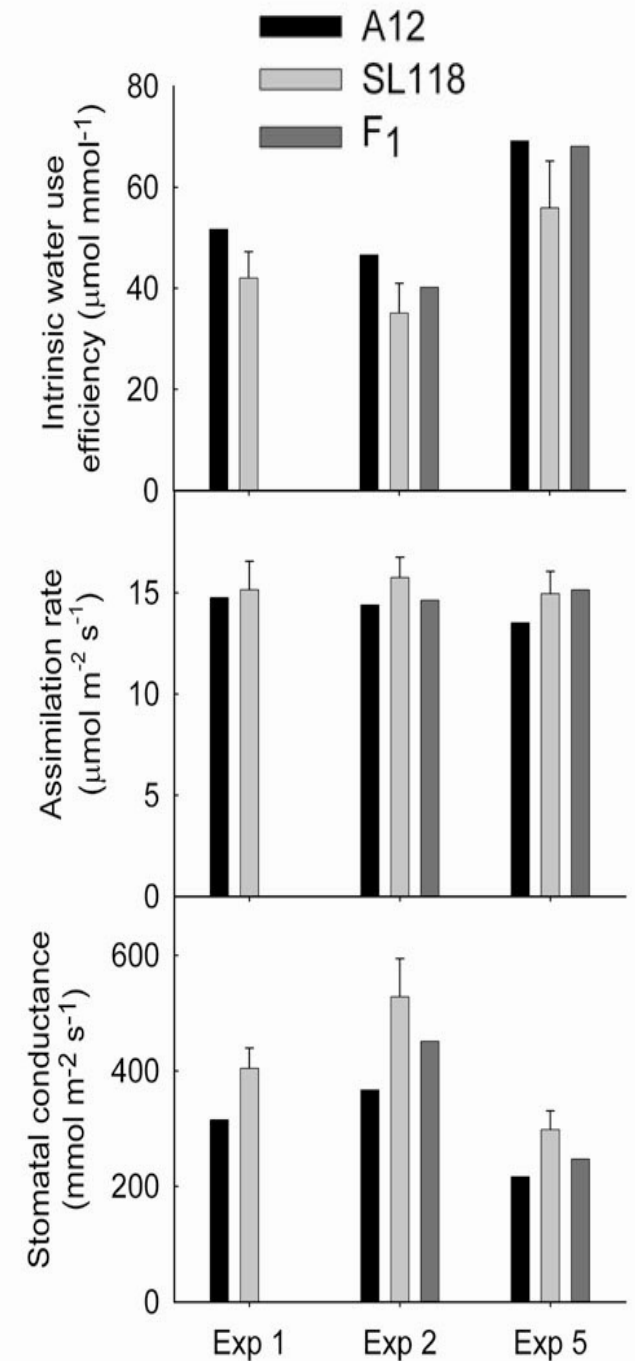
- Mean
- Drought ●
- Control ◆

cM

0  
50  
100

## 2. Glasshouse assessments of GD33 substitution lines in A12 background

- SL118 (chr 1, 6, 7) reproducible 20% decrease in WUE, glass and field
- biomass similar to A12
- F<sub>1</sub> shows A12 dominant for WUE<sub>p</sub>, but co-dominant for WUE<sub>i</sub>





### 3. Association mapping in *B. oleracea* diversity sets

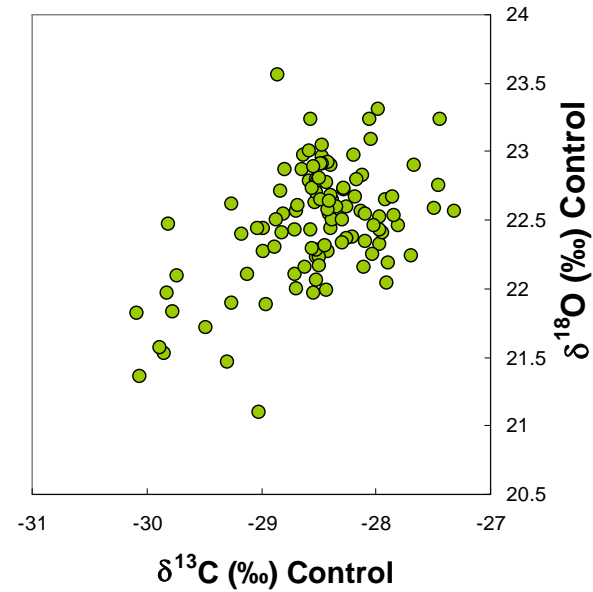
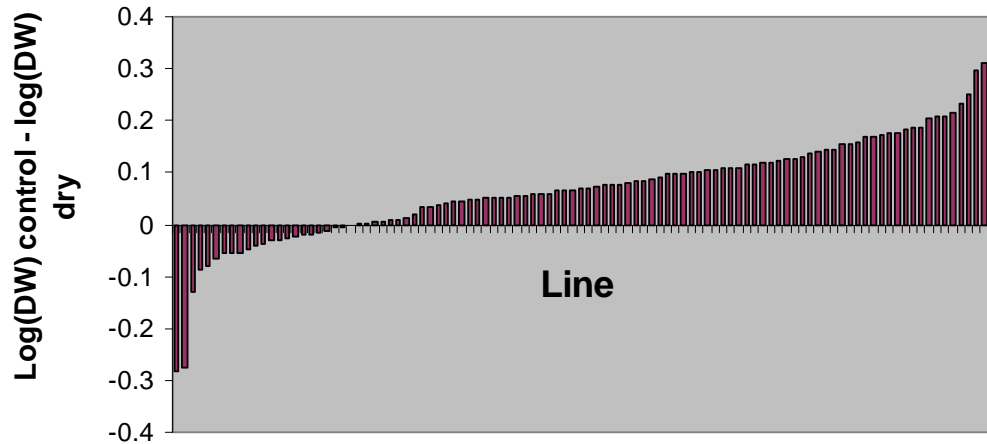


W-HRI foundation sets grown at Kirton (110 lines), two transplantings, 2 irrigation treatments  
Data collected for:

- Biomass response to irrigation
- $\delta^{13}\text{C}$
- $\delta^{18}\text{O}$
- Indicators of photosynthetic capacity (leaf thickness and SPAD)

# WUE and biomass in 110 lines of *B. oleracea* foundation diversity set

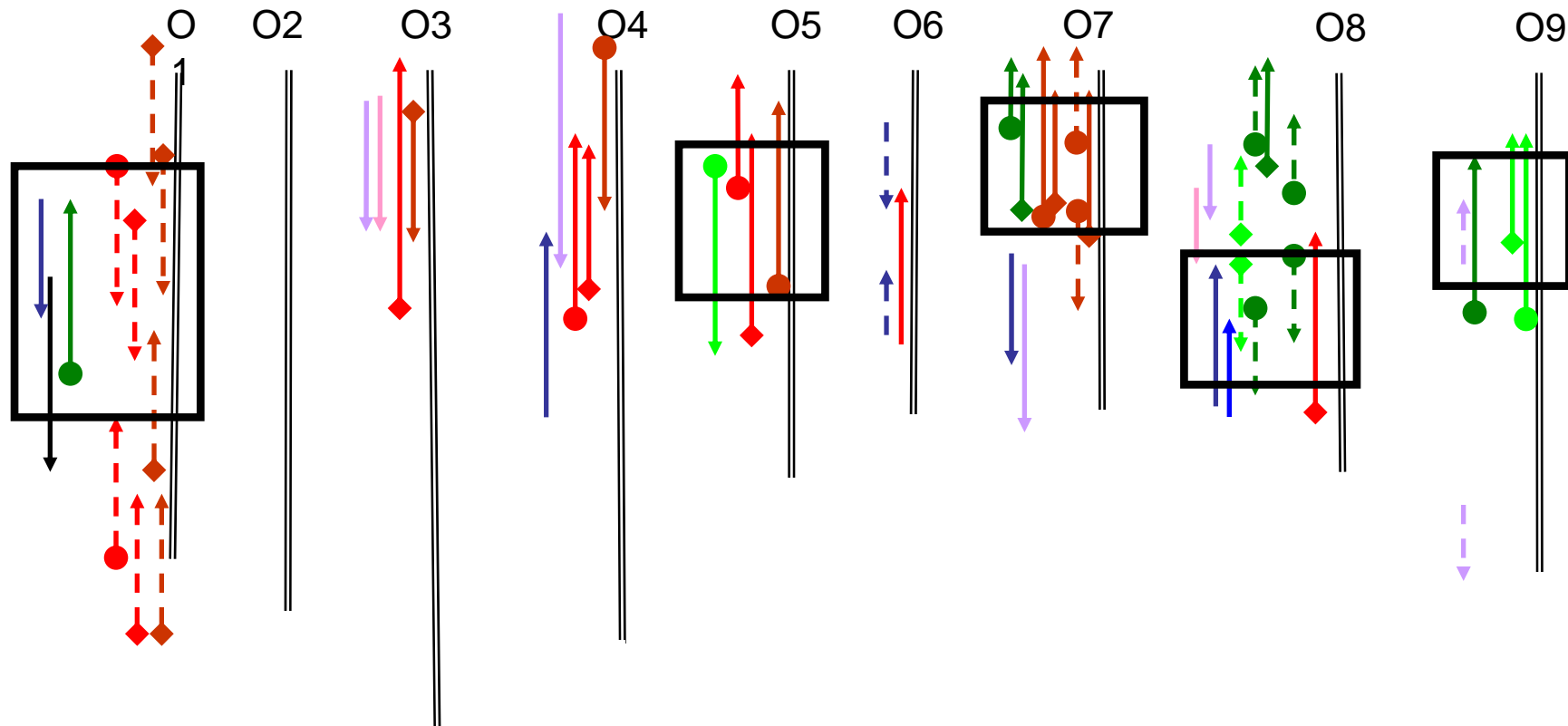
Yield response of diversity set (110 lines)



Decreasing  
Transpiration

Increasing WUE

# Regions for marker development for association analysis



35 new markers being genotyped in the diversity set in these regions (Carol Ryder)

# 4. Parallel studies in Arabidopsis/comparative analysis

(Jean-Charles Deswarte/New Defra)

- QTL maps in Col-gl1 x Kas-1 (Somerville) and Nok-3 x Ga-0 (Bancroft)
- Association mapping in Nordborg 96
- Construction of NILs and fine mapping

