Identification of genetic markers for water-use-efficiency (WUE) in horticultural crops

2004-2009

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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 = yield/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

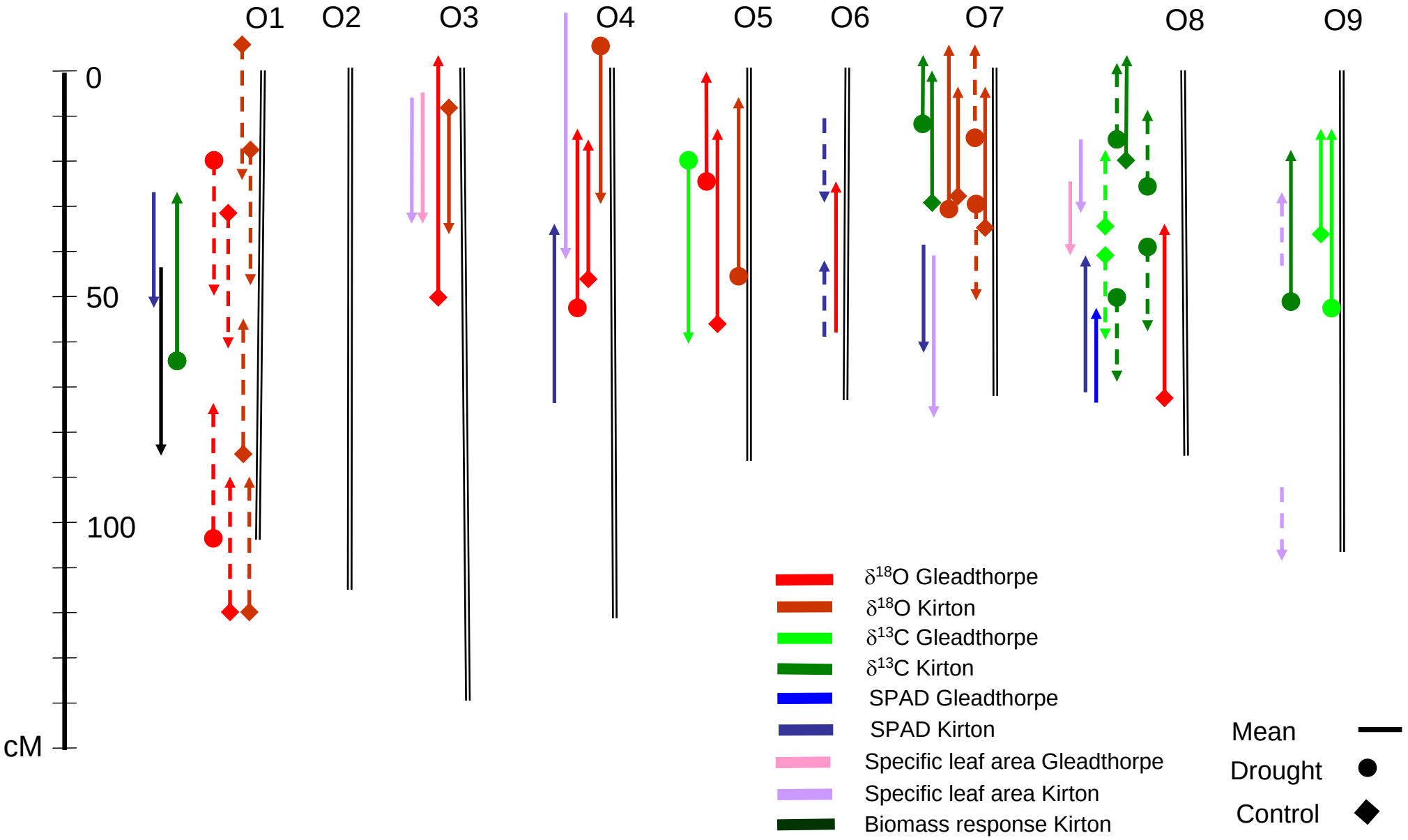
= CO_2 assimilation/stomatal conductance

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

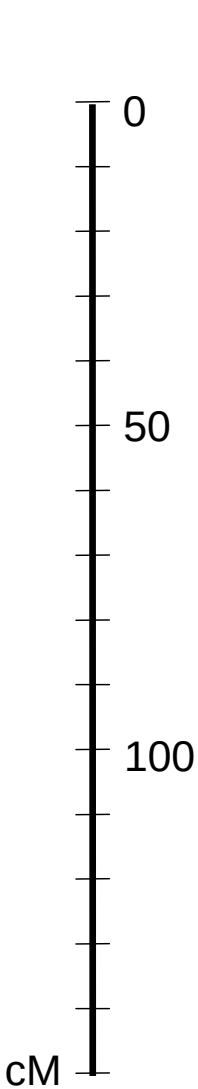
1. Identification of QTL in *B. oleracea* A x G populations

Spanish tunnels - Kirton

QTL for WUE traits in A x G DH population

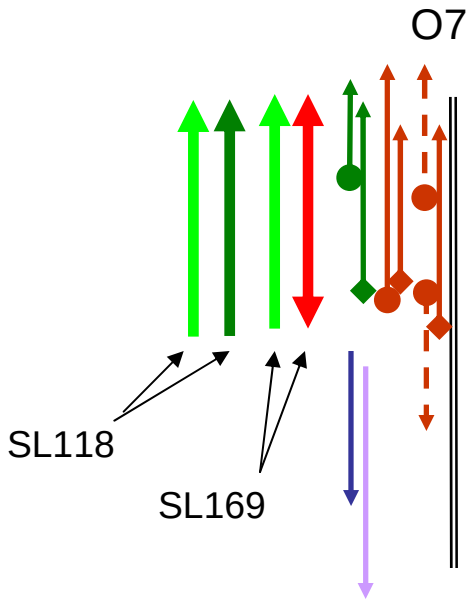


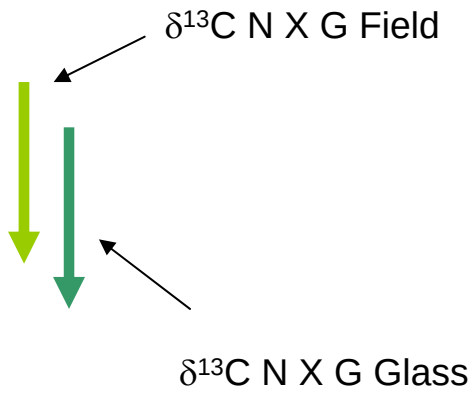
Conclusions from *B.oleracea* Linkage Group 7



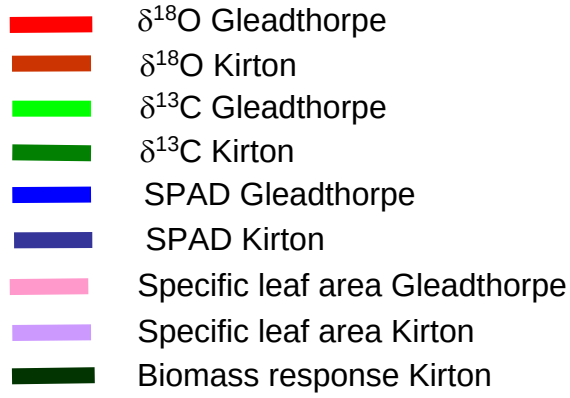
Low transpiration colocalises with high WUE QTL at Kitron.

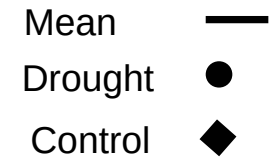
SL lines and N x G DH QTL support WUE QTL at both sites.





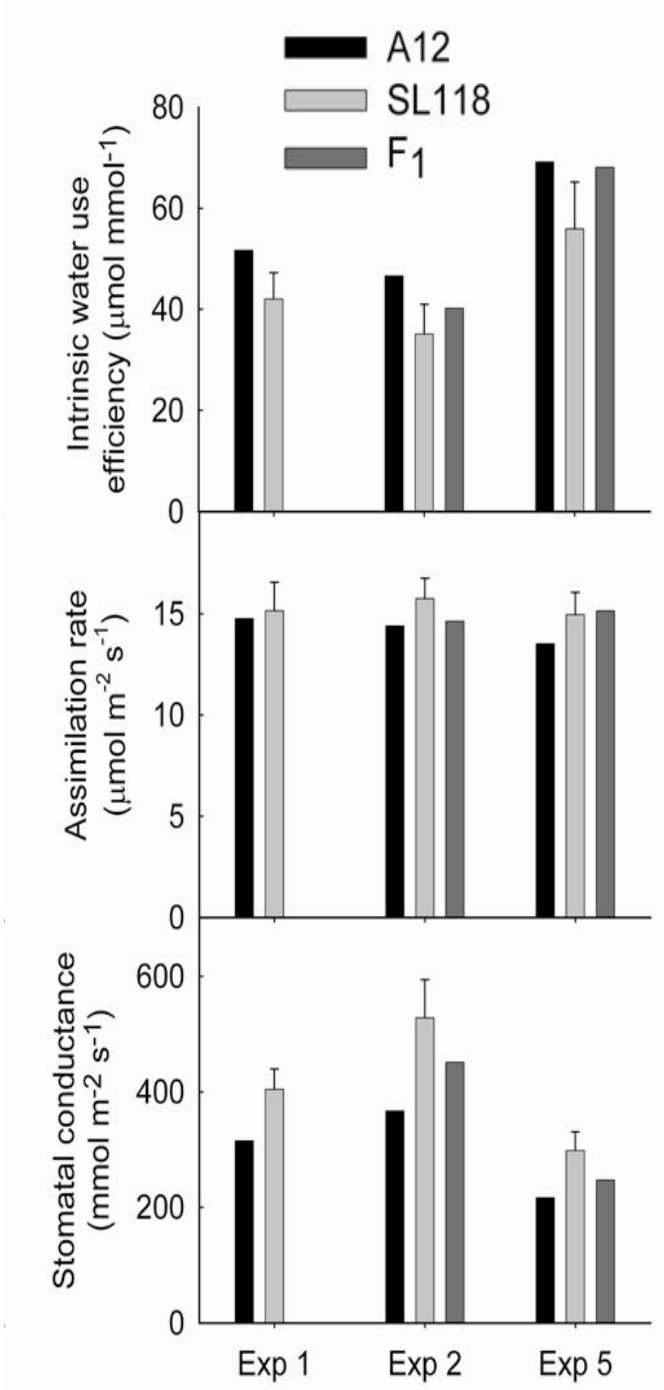
A x G – up arrow *A12* is positive allele
N x G – up arrow *Nedcha* is positive allele





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_1 shows A12 dominant for WUE_p, but co-dominant for WUE_i

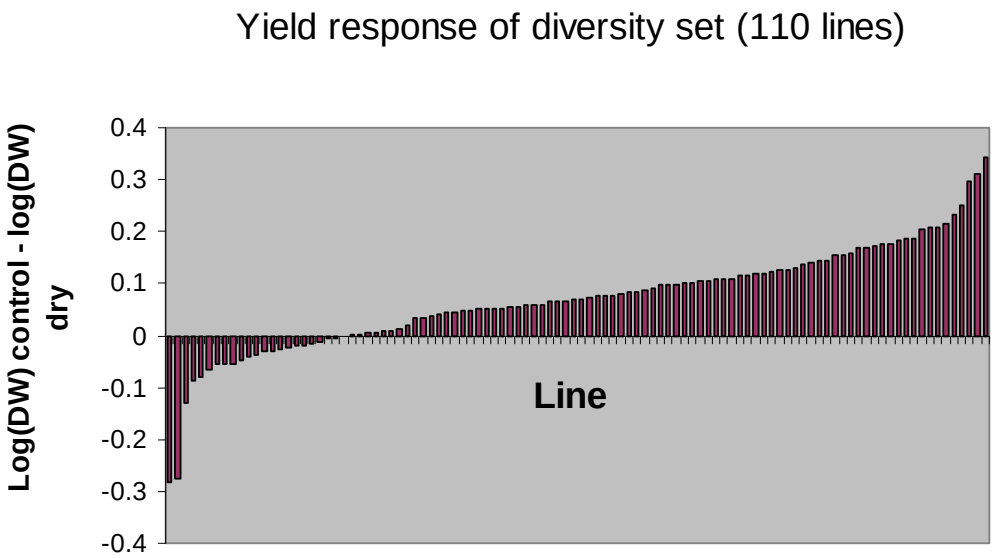


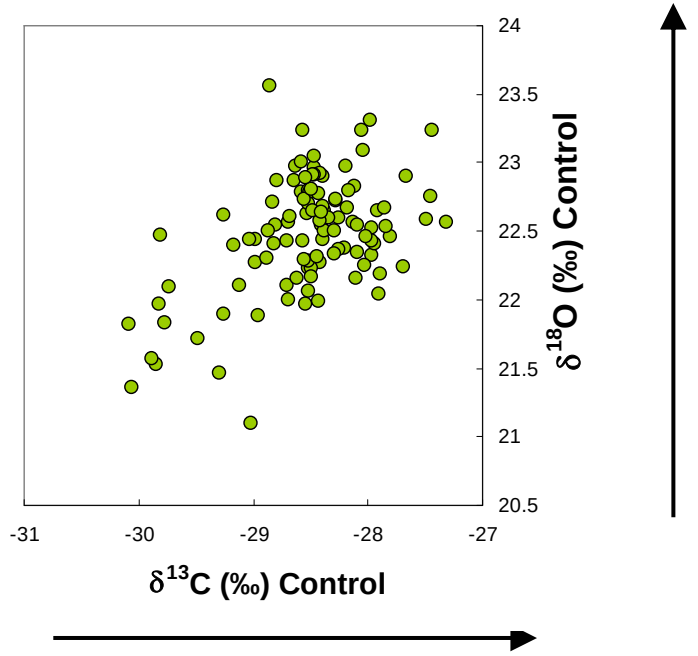
3. Association mapping in *B. oleracea* diversity sets

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

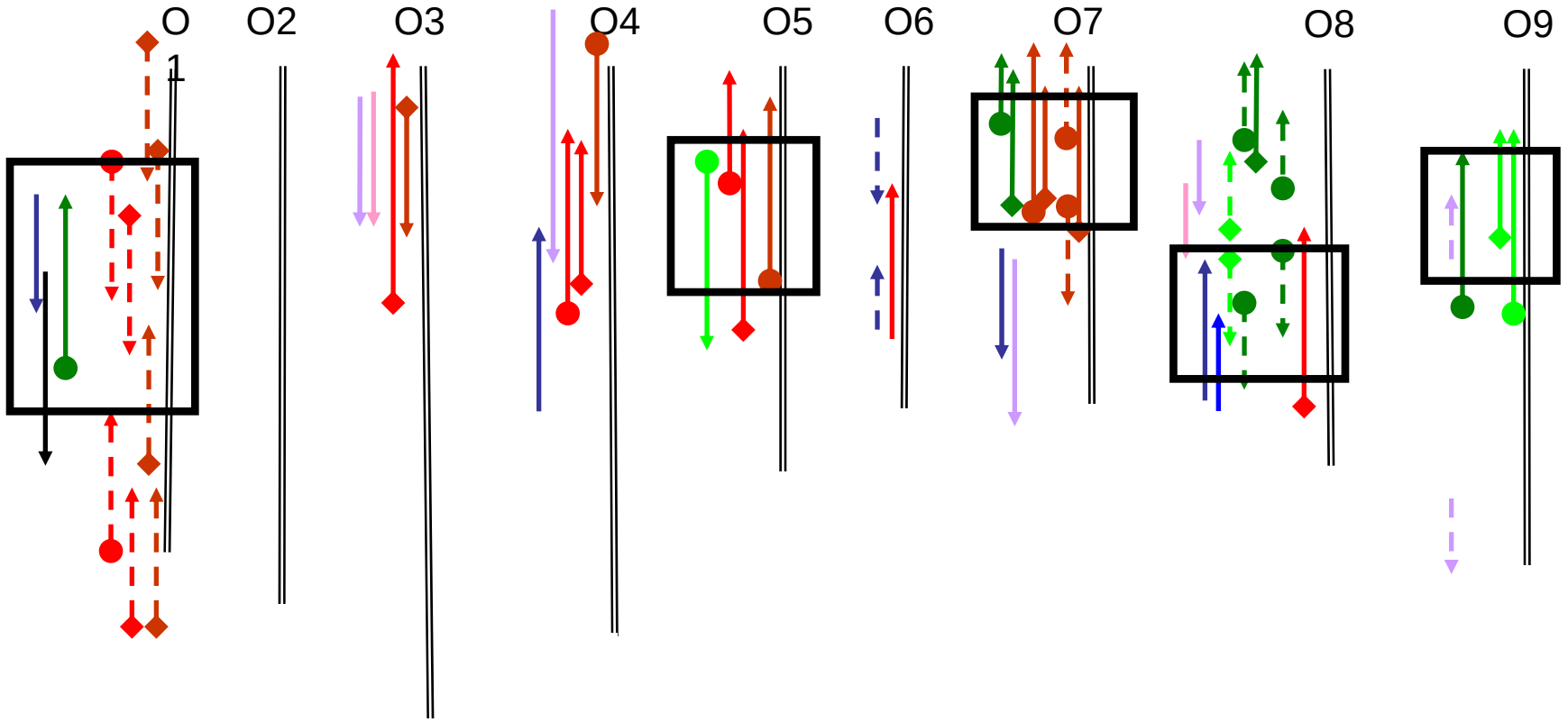
- Biomass response to irrigation
- $\delta^{13}C$
- $\delta^{18}O$
- Indicators of photosynthetic capacity (leaf thickness and SPAD)

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





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