

Plant Selection for High Yield at Elevated Atmospheric [CO₂]

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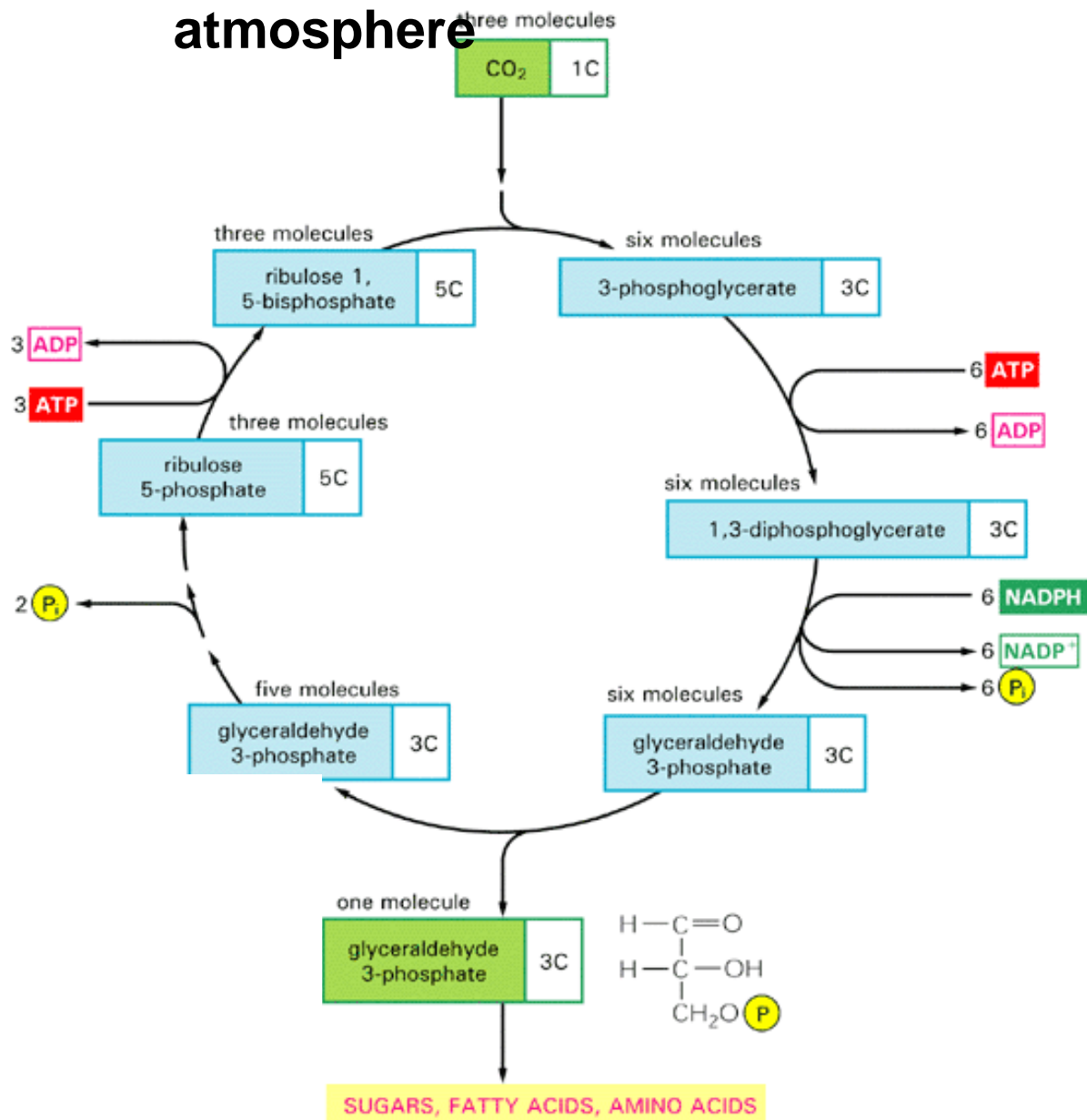
QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

700 - 1000 ppm

385 ppm

270 ppm

Calvin-Benson cycle



Photosynthesis

$\text{CO}_2 + \text{RuBP}$



3-Phosphoglycerate



Net carbon gain

Photorespiration

$\text{O}_2 + \text{RuBP}$



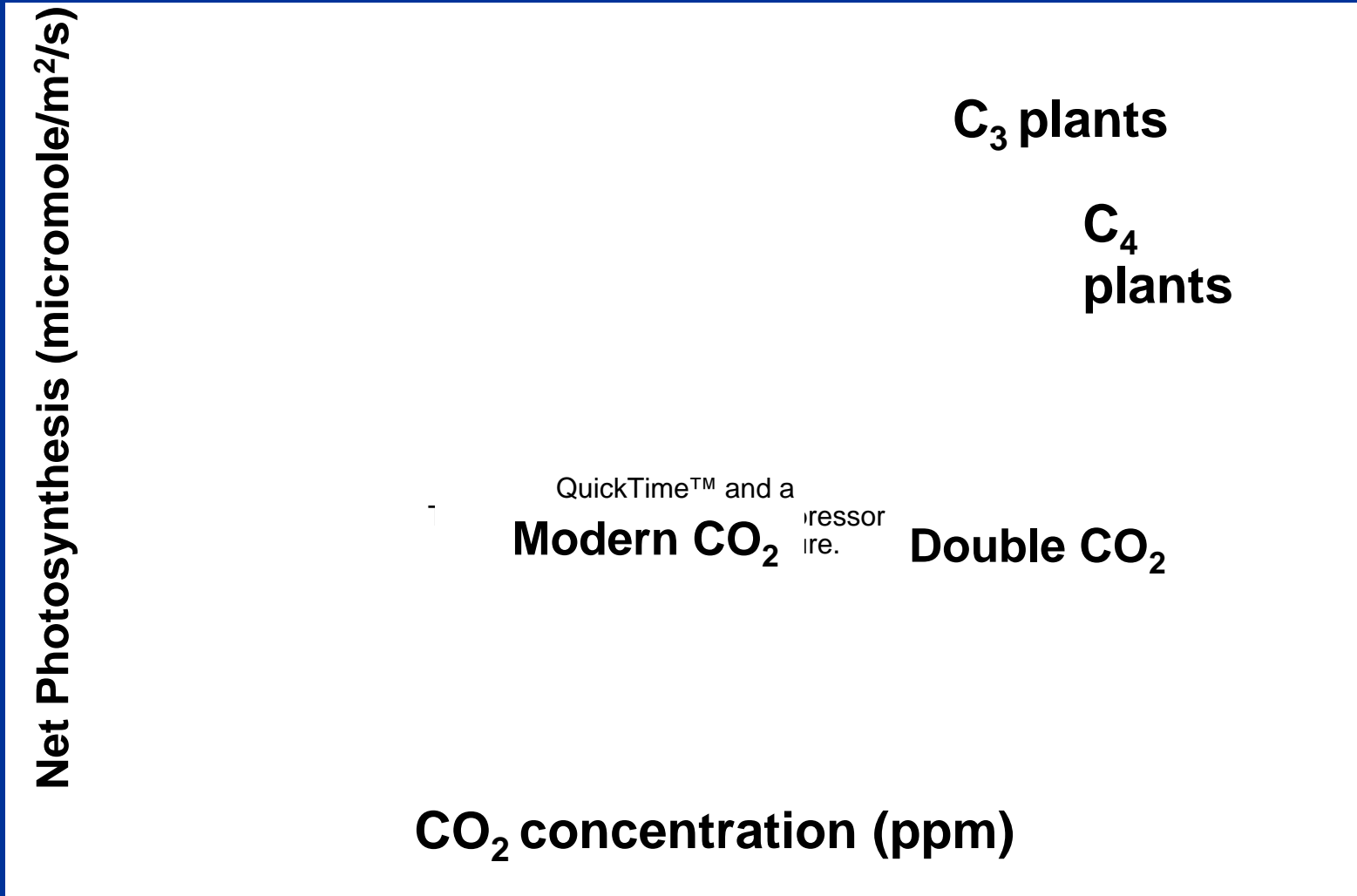
2-Phosphoglycolate



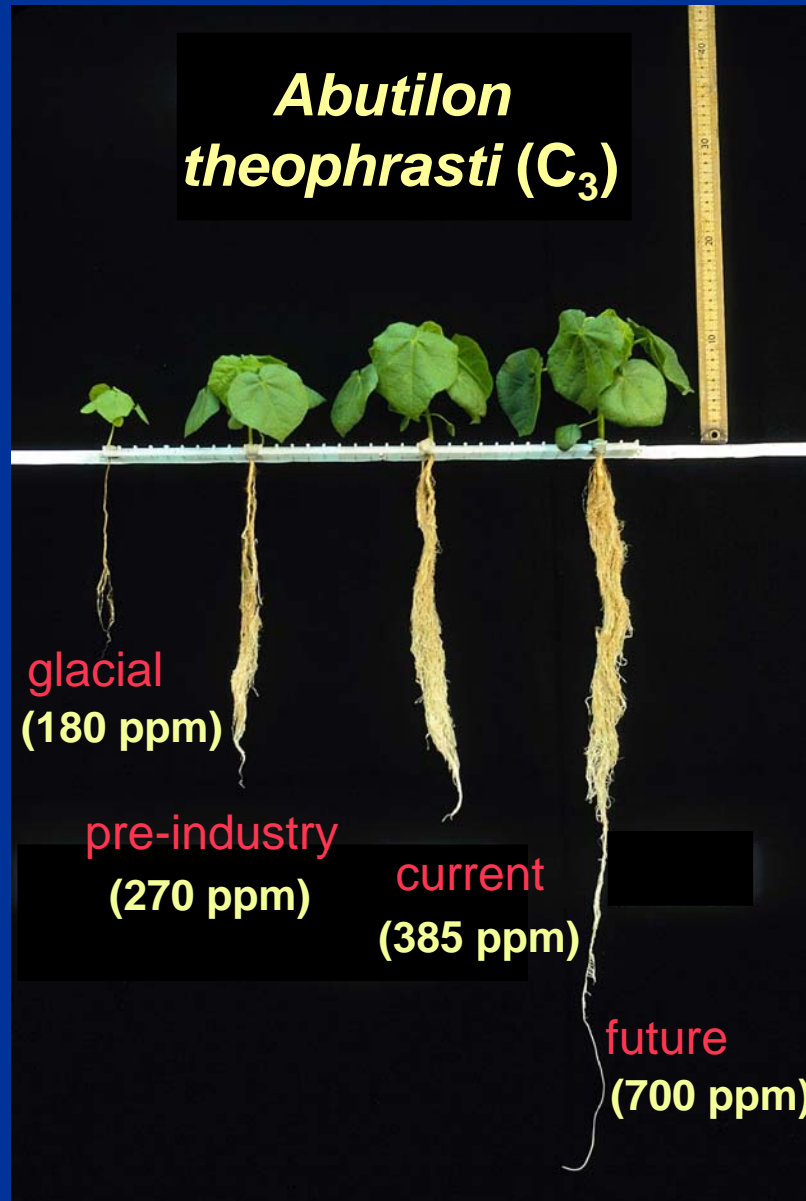
Net carbon loss

The rate of these processes is influenced by the $[\text{CO}_2] / [\text{O}_2]$ ratio

Photosynthetic responses to atmospheric [CO₂]

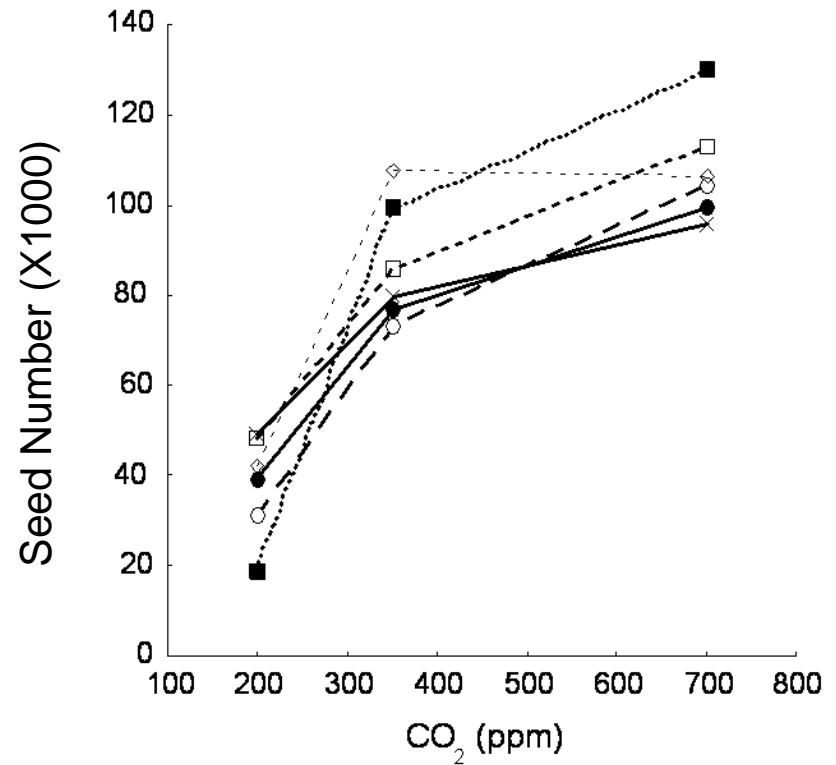
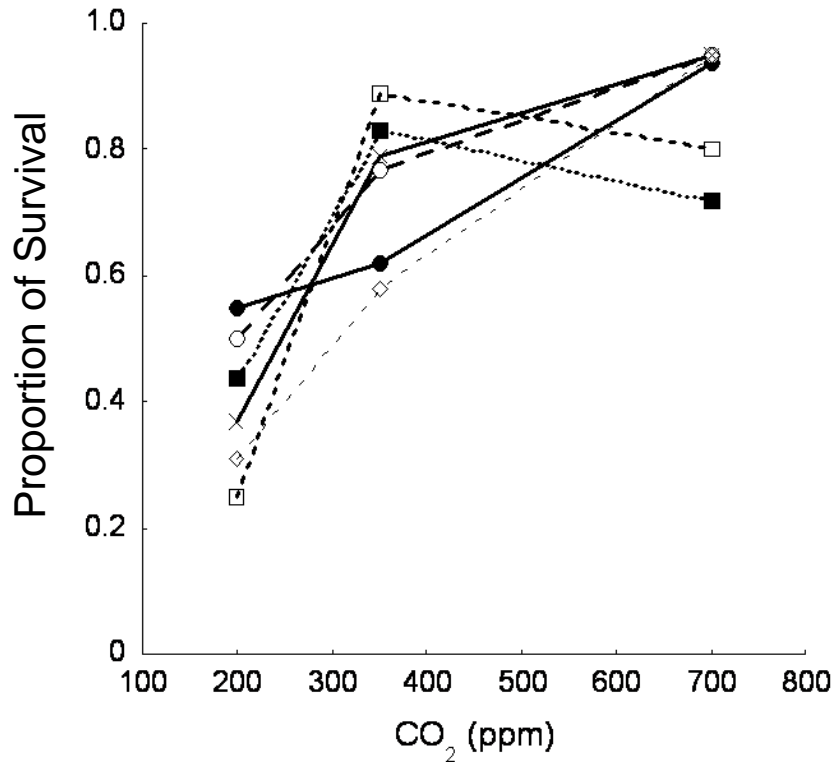


Growth responses to atmospheric [CO₂]



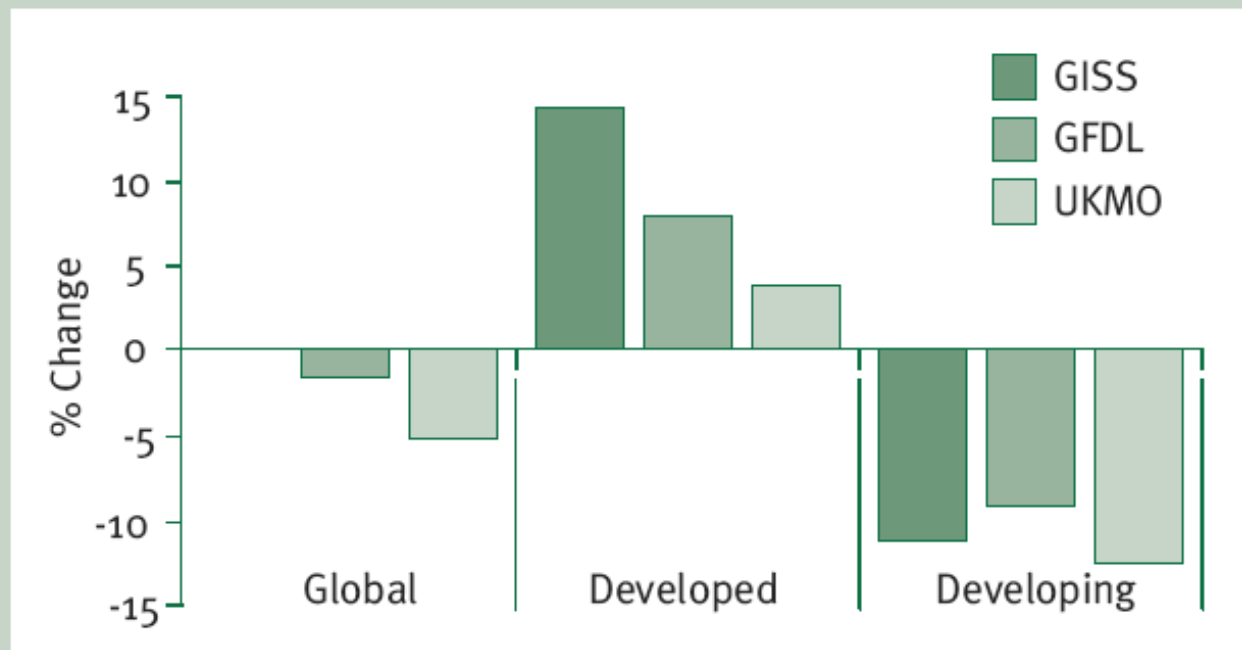
Potential for selection responses to elevated CO₂

Arabidopsis thaliana (wild genotypes)



Cereal production at elevated [CO₂]-passive response

Figure 1: Change in cereal production in developed and developing countries for a doubling of CO₂ levels



Note: Percentage changes for a 3°C warming in the three models used, are relative to what they would have been without climate change. Assumptions: mostly farm level adaptation; some economy wide adaptation; strong CO₂ fertilisation effect.

Source: Stern 2006

Biofuel production could be enhanced due to crop selection at elevated [CO₂]

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Arabidopsis as a model system for selection at elevated [CO₂]

Self-pollinating

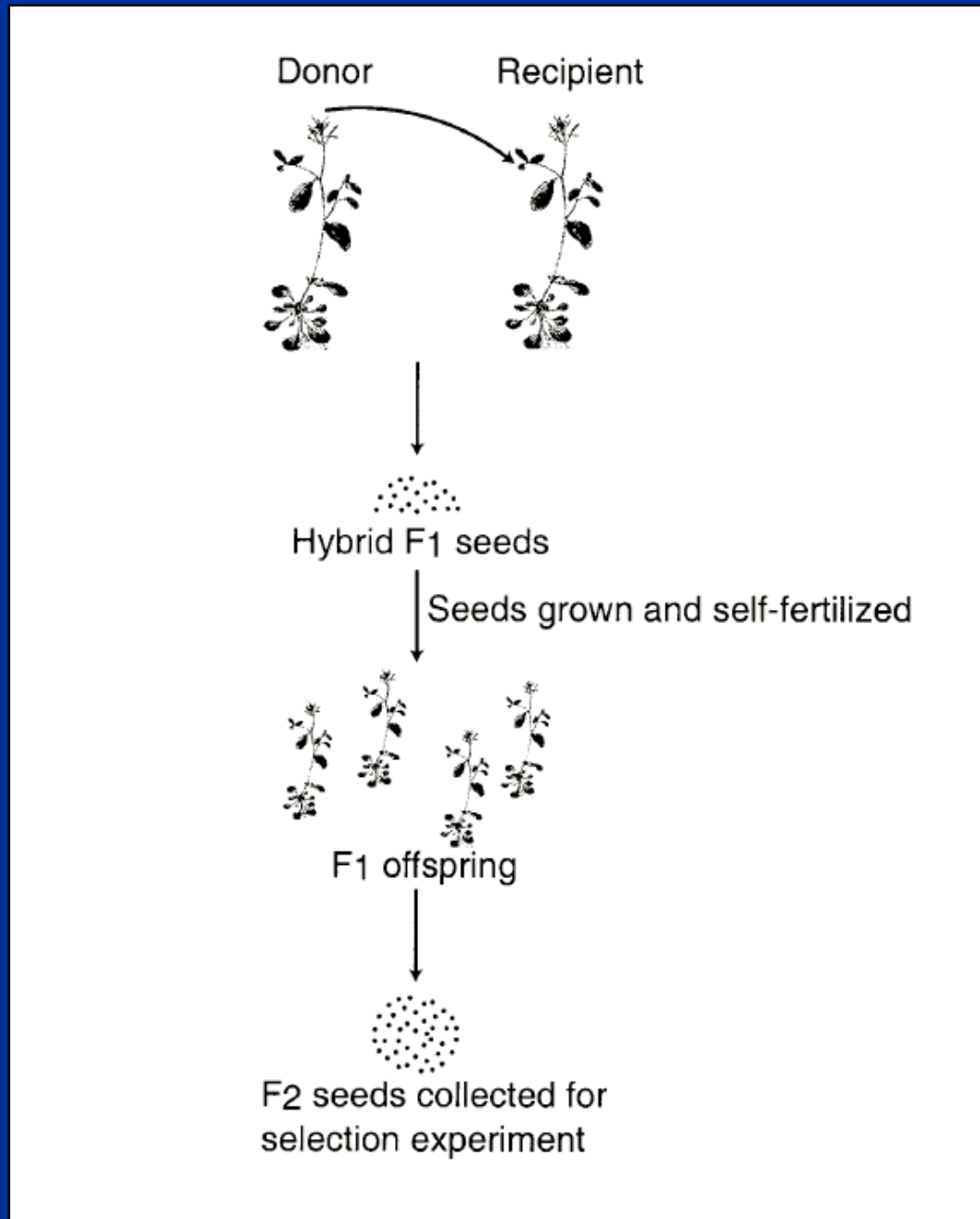
Short generation time

Can be grown under controlled conditions

Now possible to sequence lab-specific genotypes for genetic and molecular studies



Crossing scheme for wild *Arabidopsis*



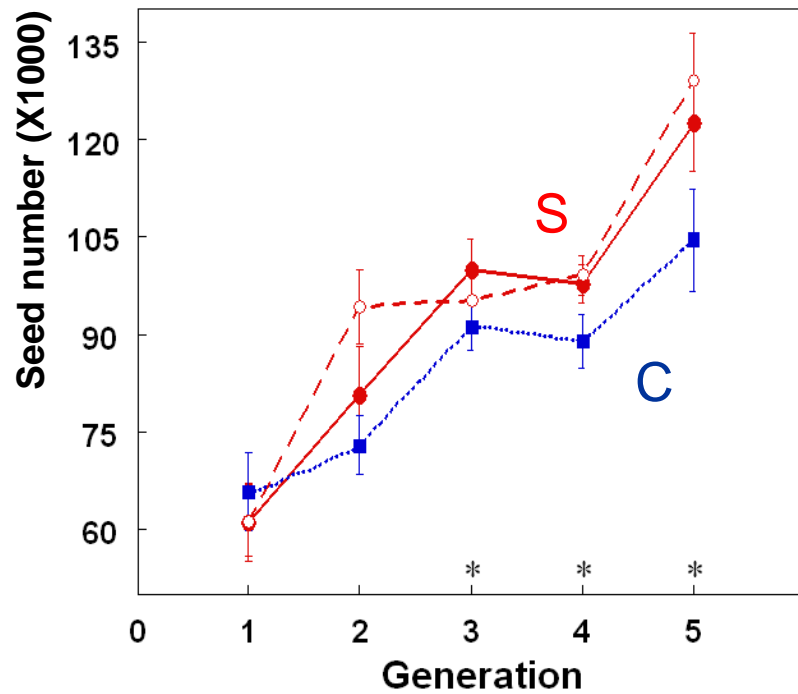
Design of the selection experiment

CO₂ Treatments: 200 ppm (ice age), 700 ppm (future)

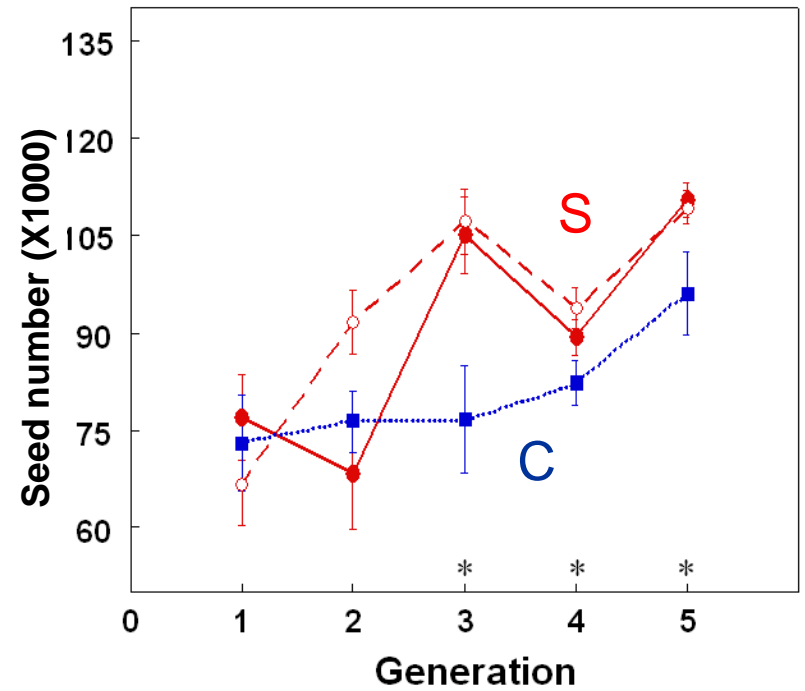
- Selection populations: selected for high seed number for 5 generations (25% truncation)
- Control populations: random selection for 5 generations
- Population size maintained at 28 plants

Selection at 700 ppm CO₂

Seed Number- selected character

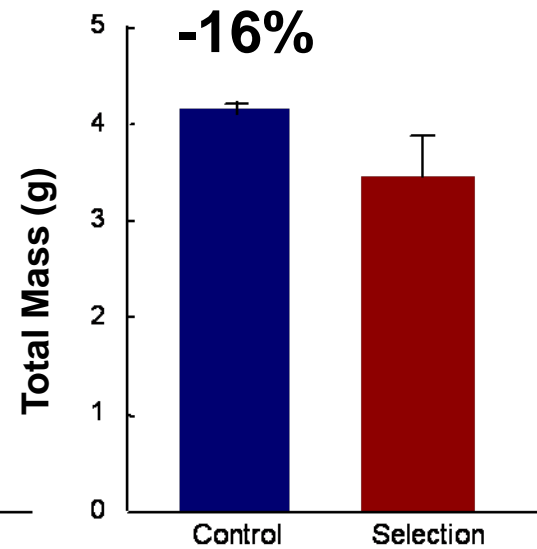
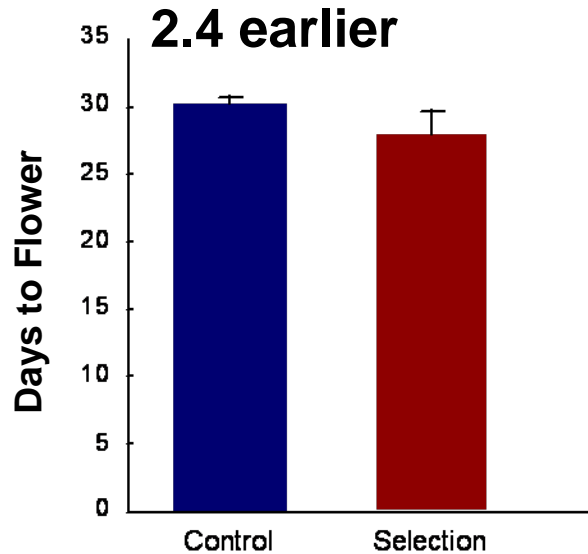
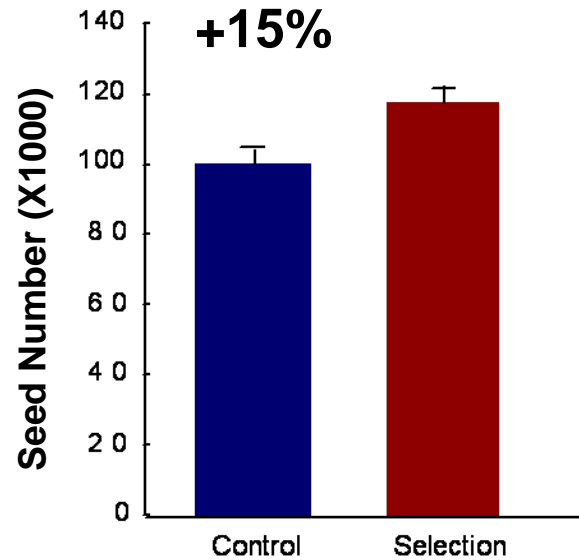


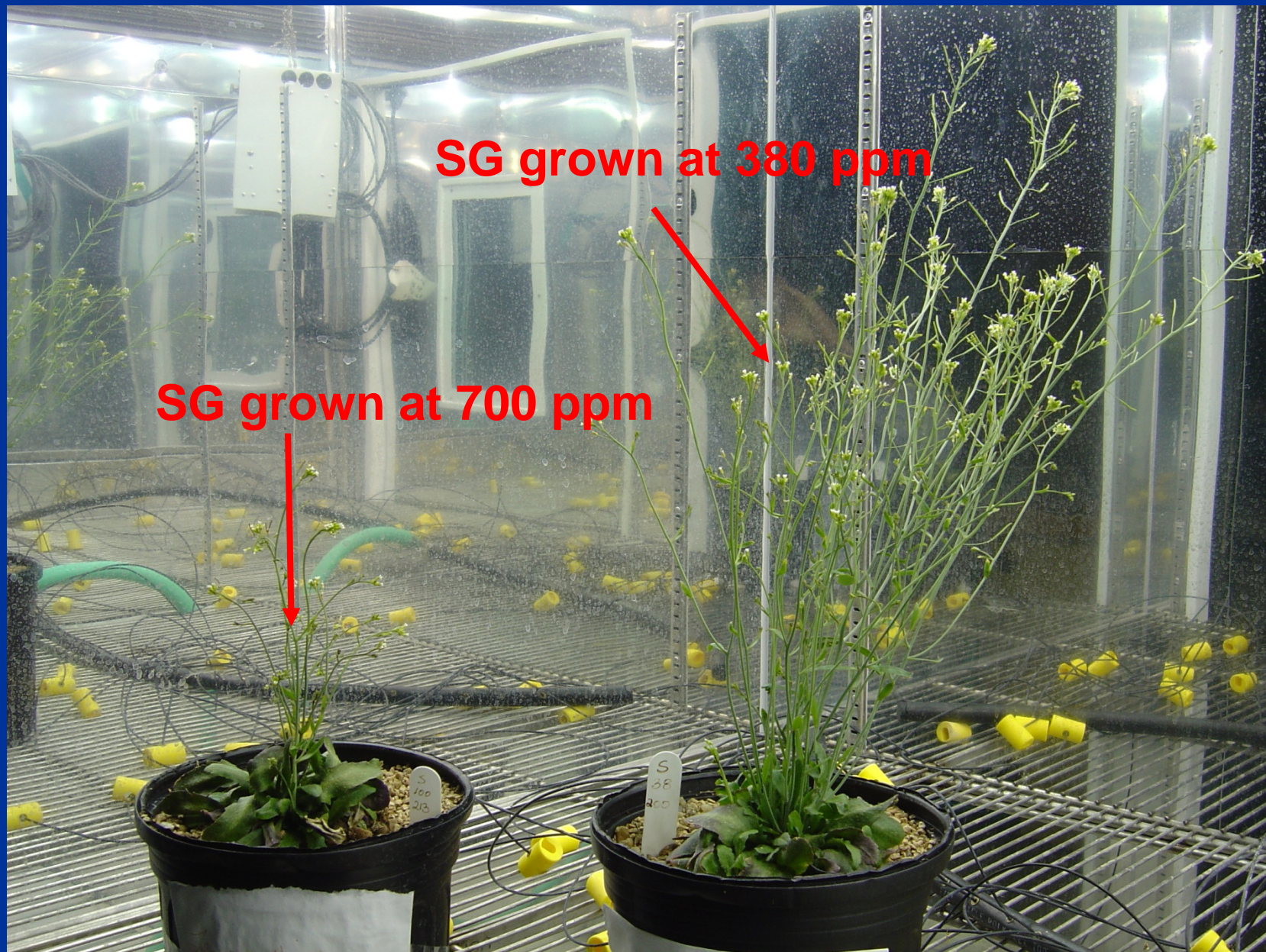
Chamber 1



Chamber 2

Selection at 700 ppm CO₂- 5th Generation





SG grown at 380 ppm

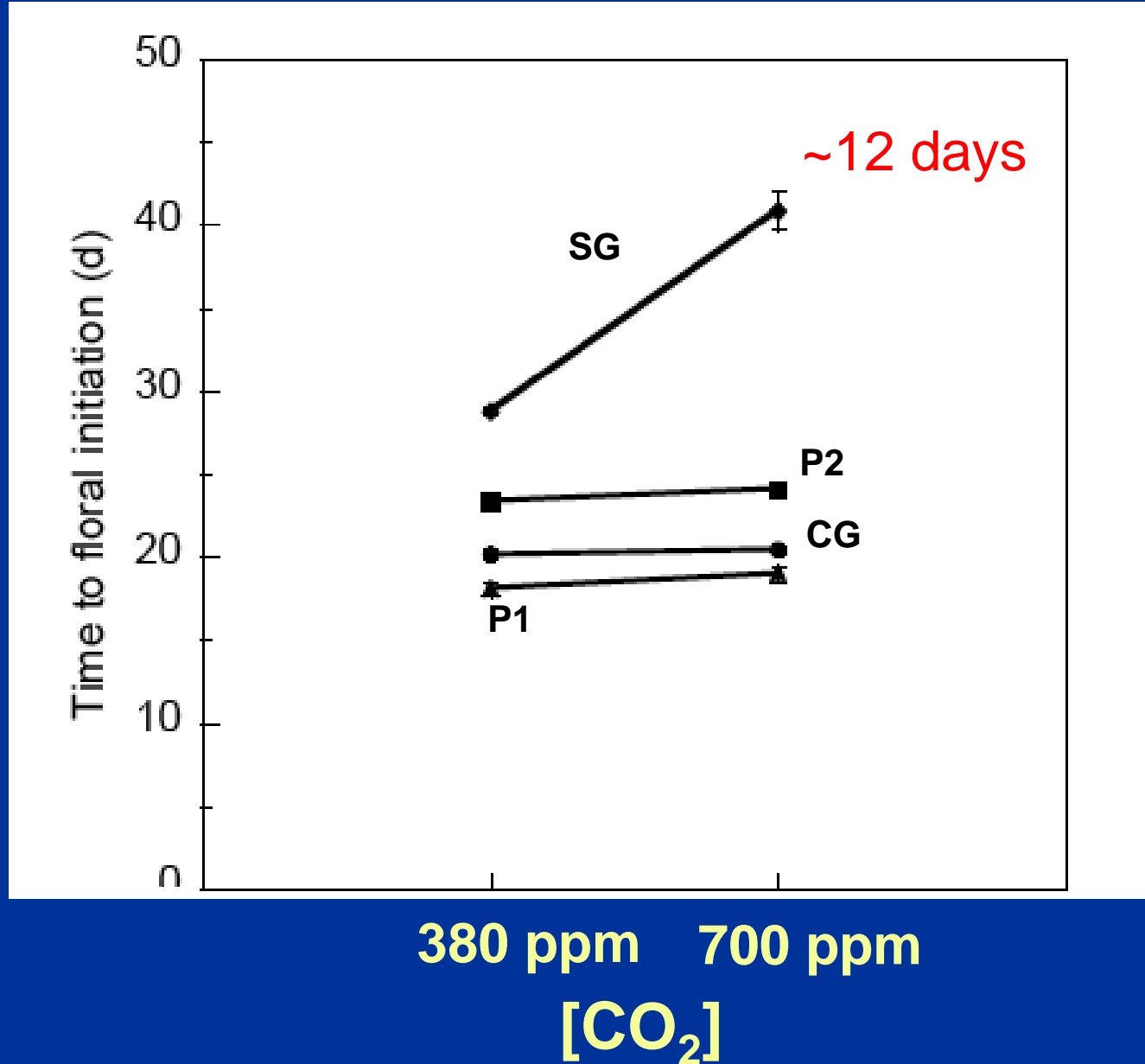
SG grown at 700 ppm



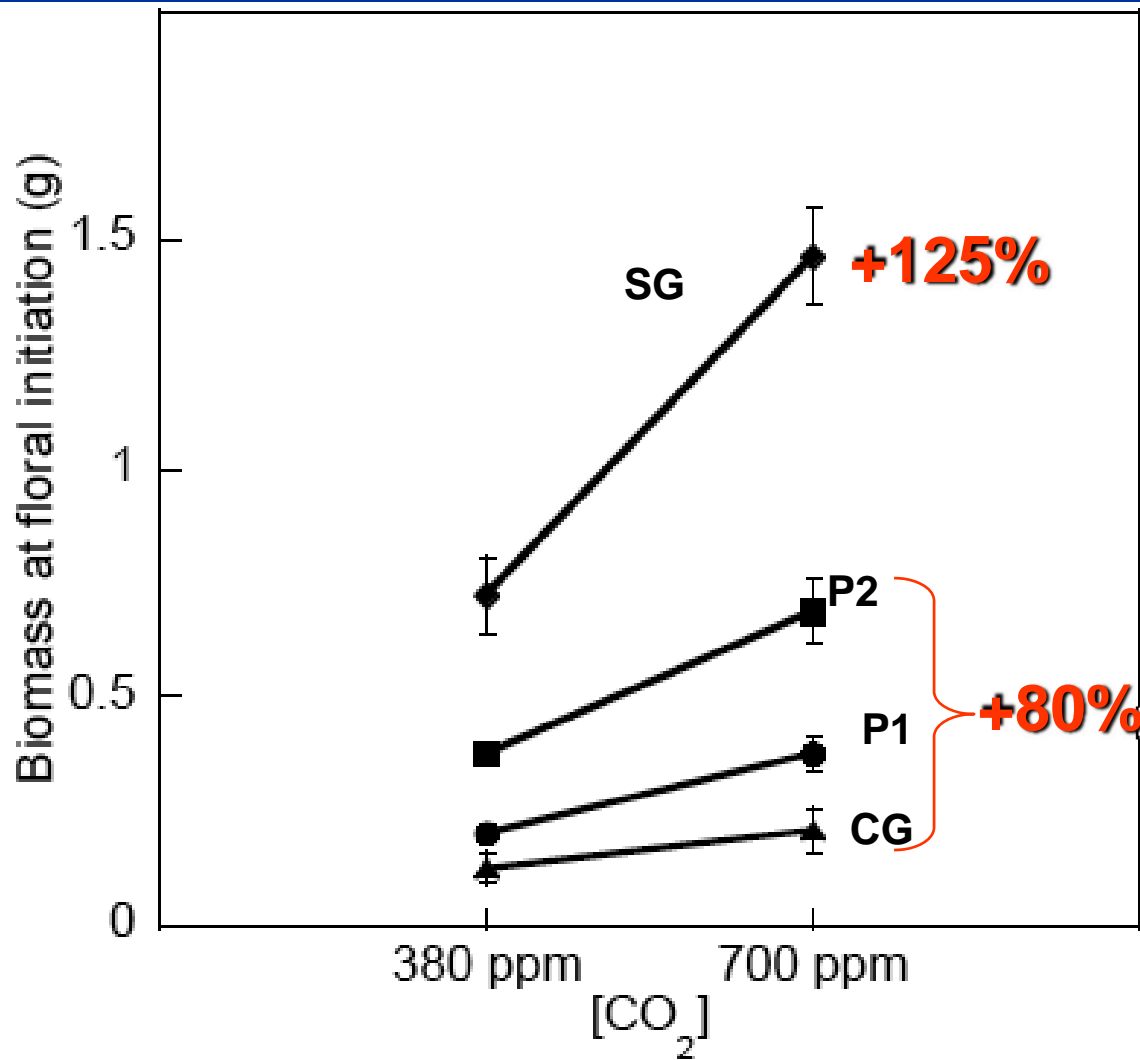
S
38
200

S
100
200

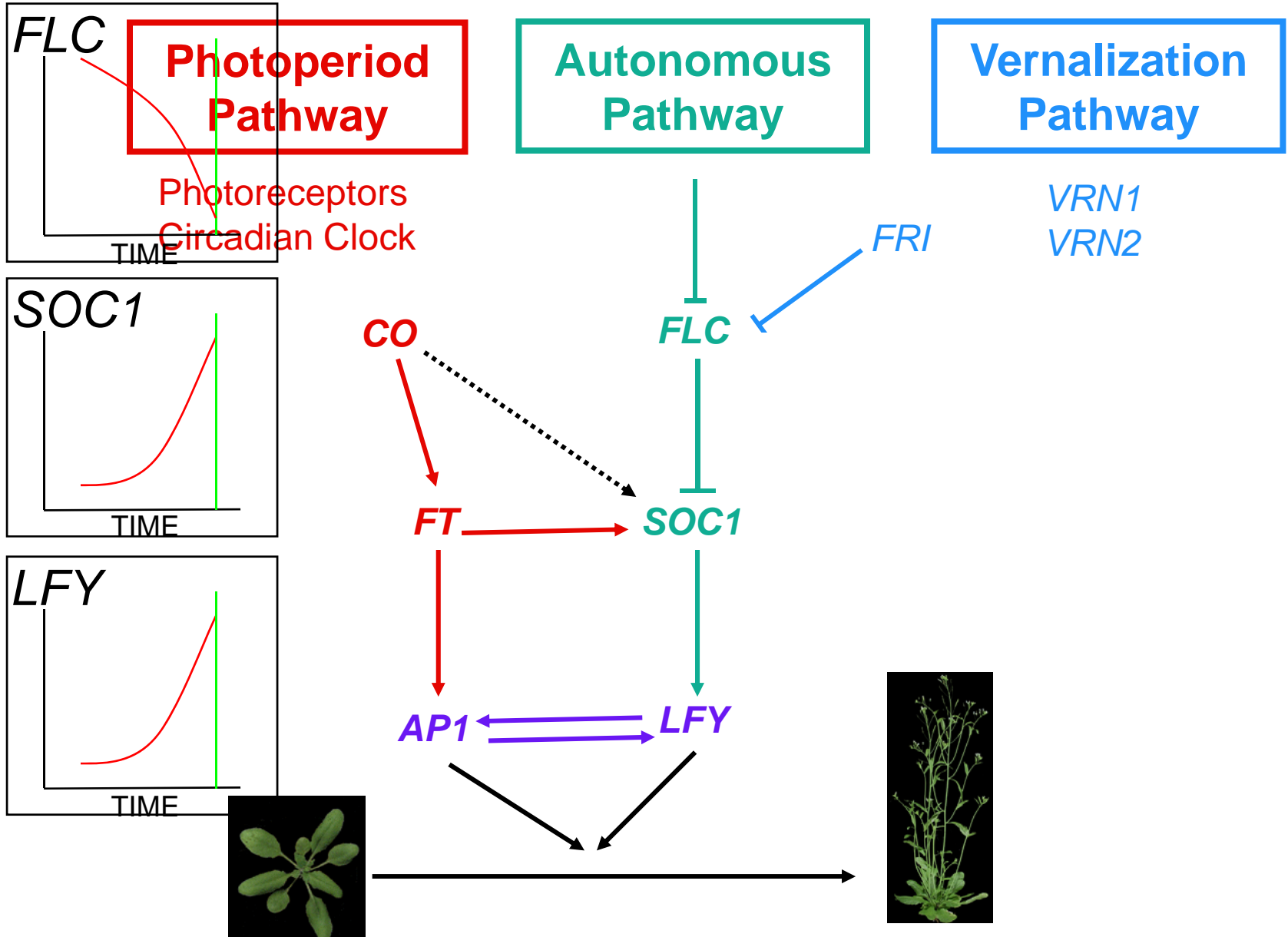
Time to Flowering

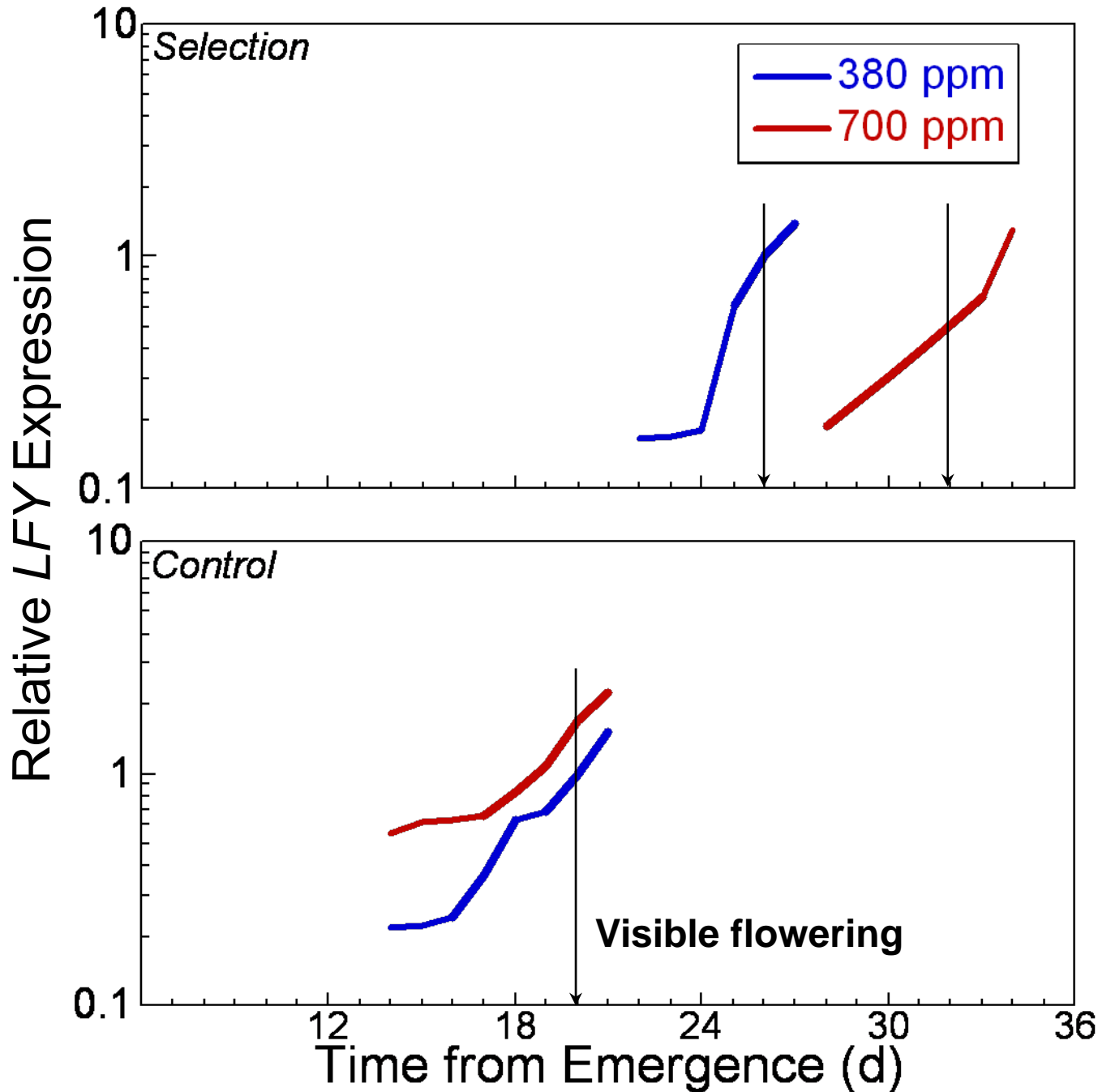
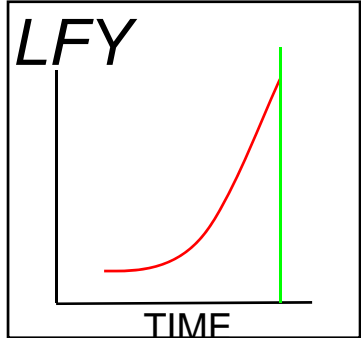


Size at Flowering



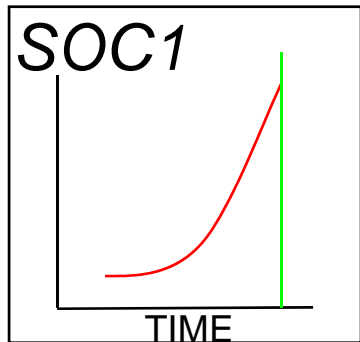
Floral signaling pathways in *Arabidopsis thaliana*



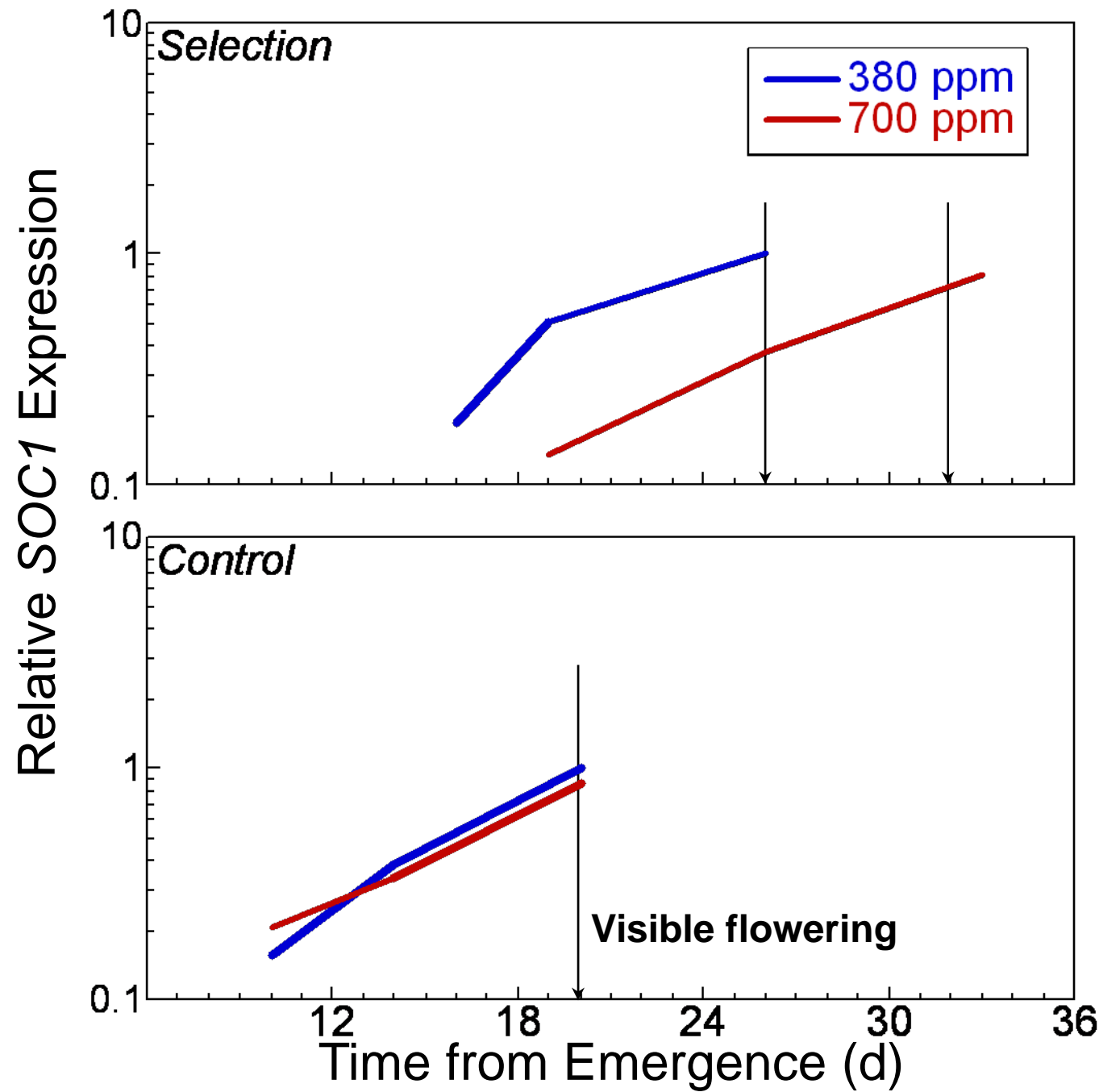


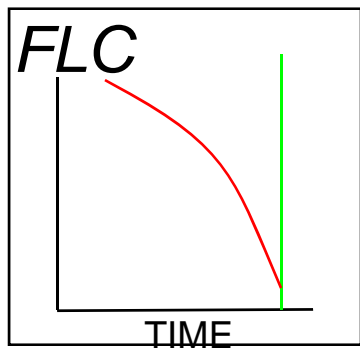
Autonomous Pathway



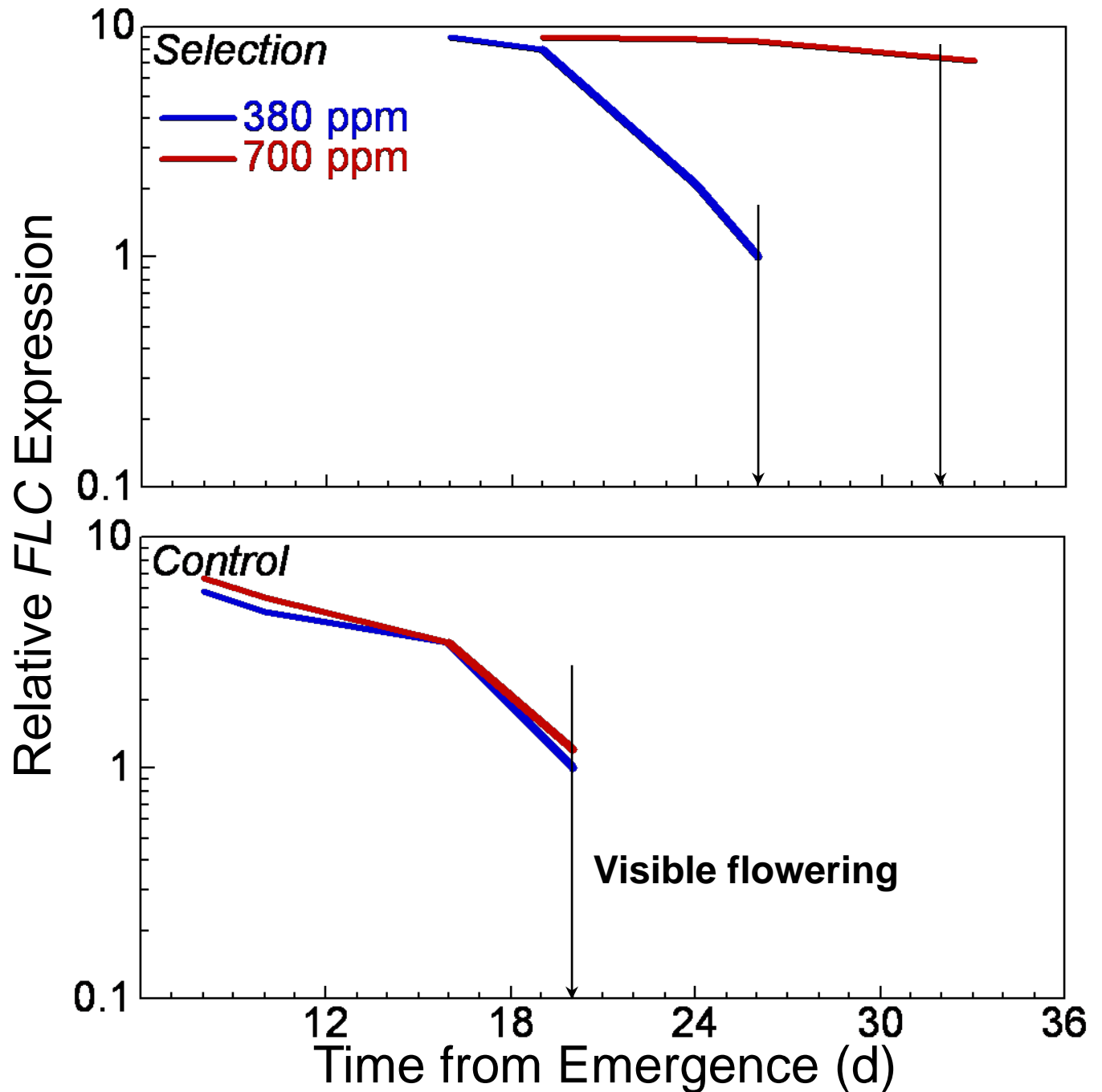
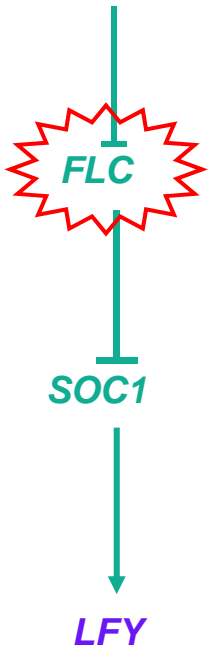


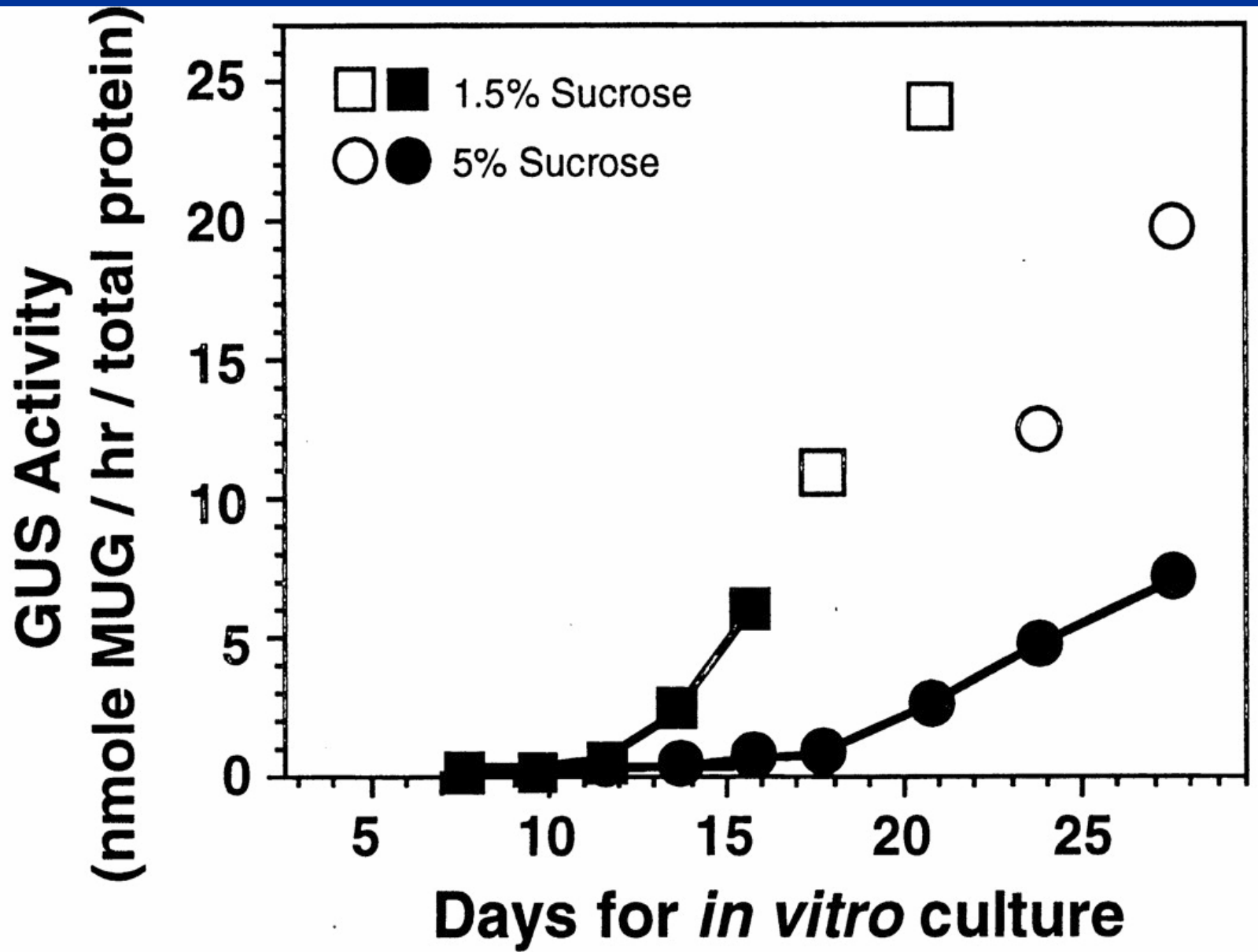
Autonomous Pathway





Autonomous
Pathway





Conclusions

- Plants can be successfully selected for high seed yield at elevated [CO₂]
- Unexpected changes may accompany selection responses (e.g. flowering time)
- Selection at elevated [CO₂] may be a highly effective approach for increasing future crop production, but one that requires further study

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