Transpiration during avocado flowering: How much water do the flowers use?

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Water stress during flowering?

- What are the causes of alternate bearing?
- Does water stress contribute to poor fruit set?
- “Flowers use 80% of the water”
- Pollen tube growth is sensitive to water potential

Previous studies

Whiley et al. (1988)

- Inflorescences increase canopy surface area of ‘Fuerte’ by 90%
- Estimated that flowers add 13% to tree transpiration

Blanke and Lovatt (1993)

- Compared the surface morphology and transpiration of leaves and flowers
- No estimates of total water use

Our hypothesis:

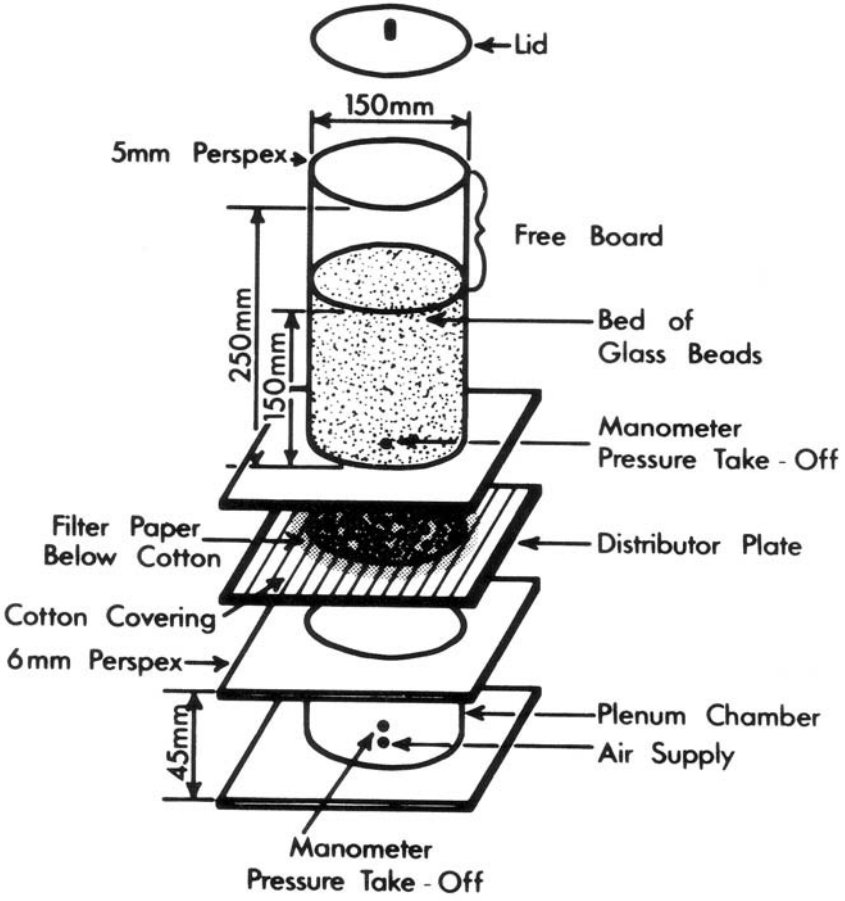
- Inflorescences add significantly to tree transpiration, leading to soil moisture deficits and plant water stress

Methods

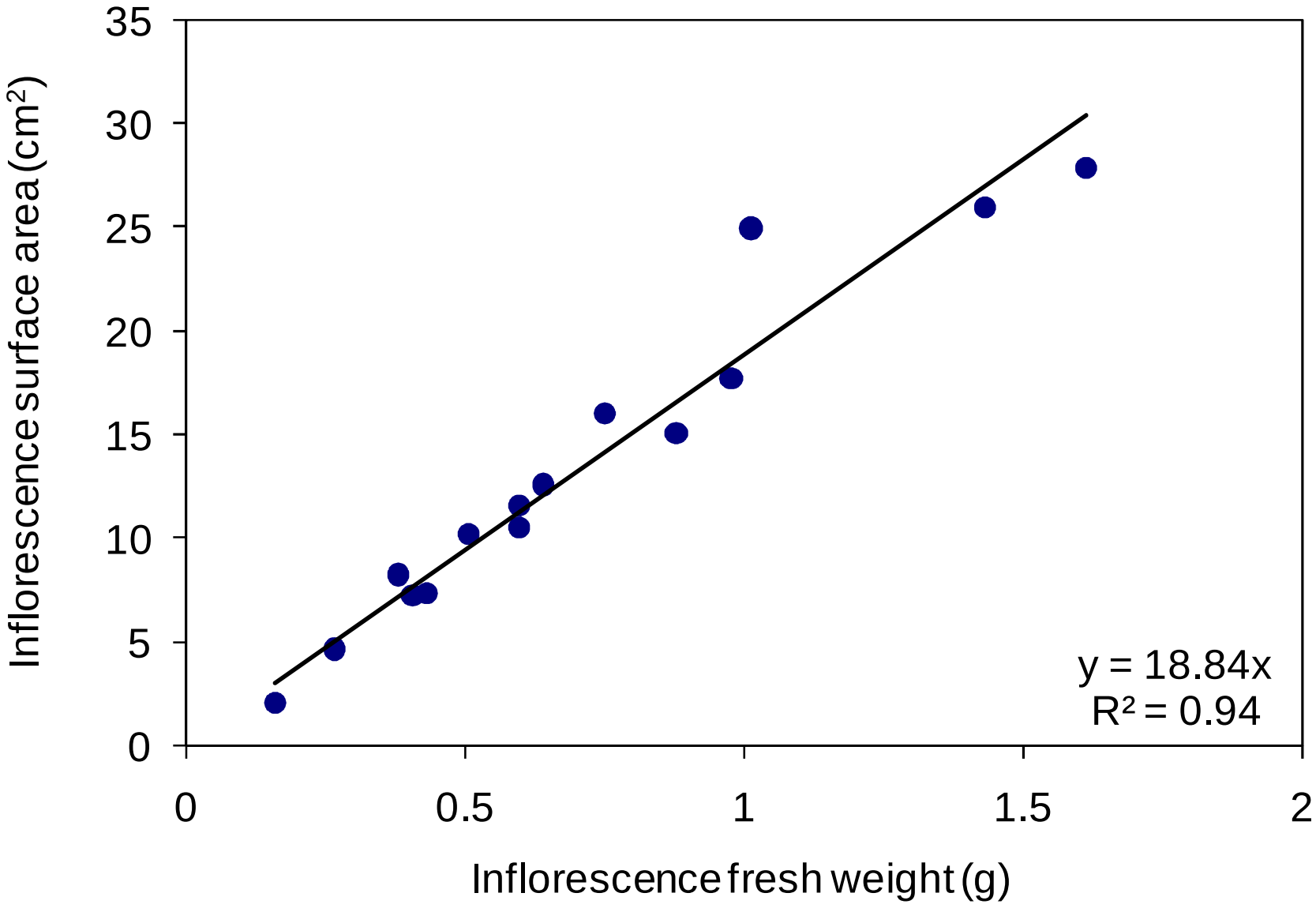
- Hass Avocado in the Bay of Plenty, New Zealand
- Flower and leaf removal from whole trees and branches
- Measured
  - inflorescence and leaf area
  - inflorescence and leaf stomatal conductance
  - tree and branch transpiration using sap flow
  - soil moisture, water potentials, photosynthesis
- Compared transpiration estimated from surface area and conductance with transpiration measured using sap flow

Measuring inflorescence surface area

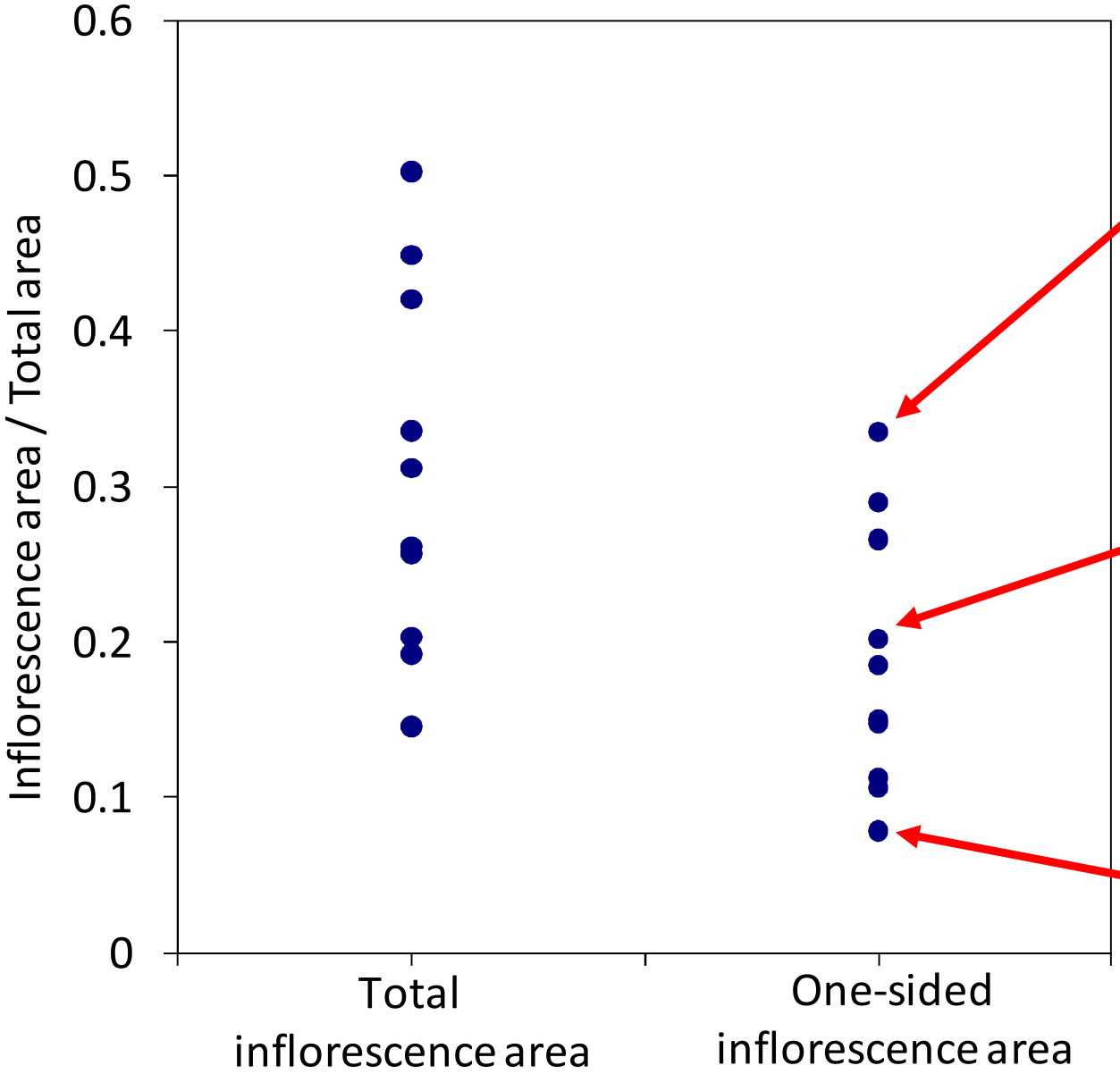
- Fluidized bed of ‘Ballotini beads’
- Dip in glue – weigh – dip in beads – reweigh
- Area = change in weight added by coating of glass beads



Inflorescence surface area correlated with fresh weight

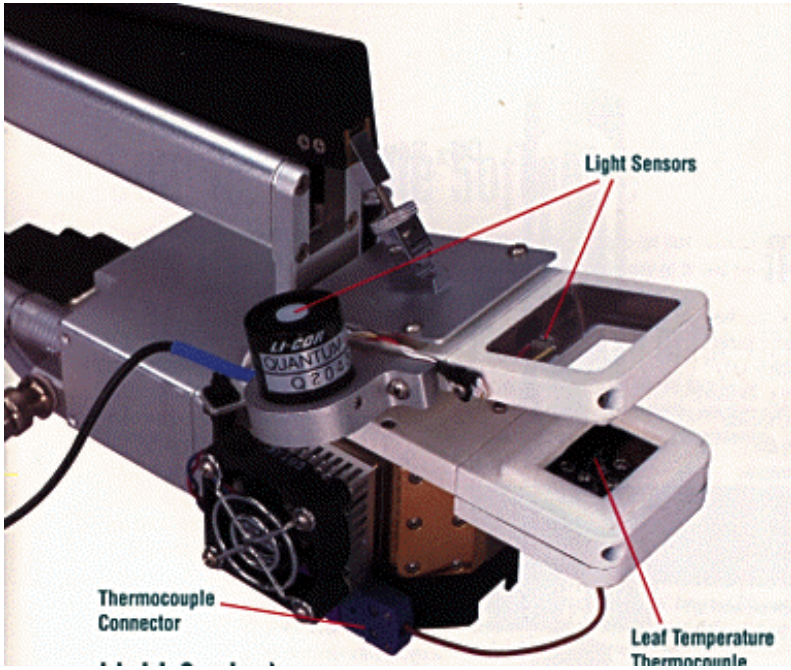


Inflorescence area as a proportion of total surface area

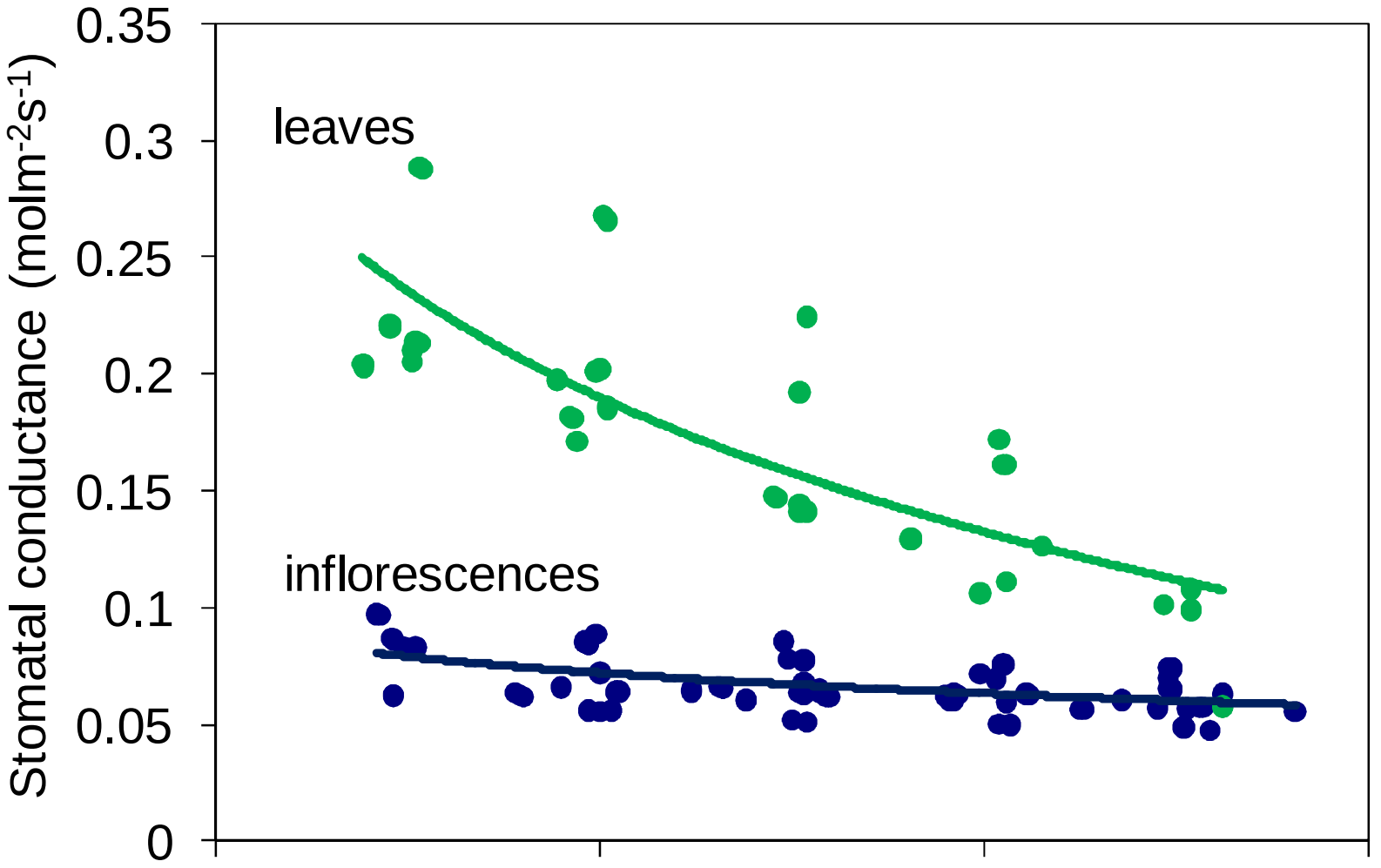


Measuring stomatal conductance

- Stomatal conductance was measured using a gas exchange system
- Response to humidity was measured as an indicator of the level of stomatal control over transpiration



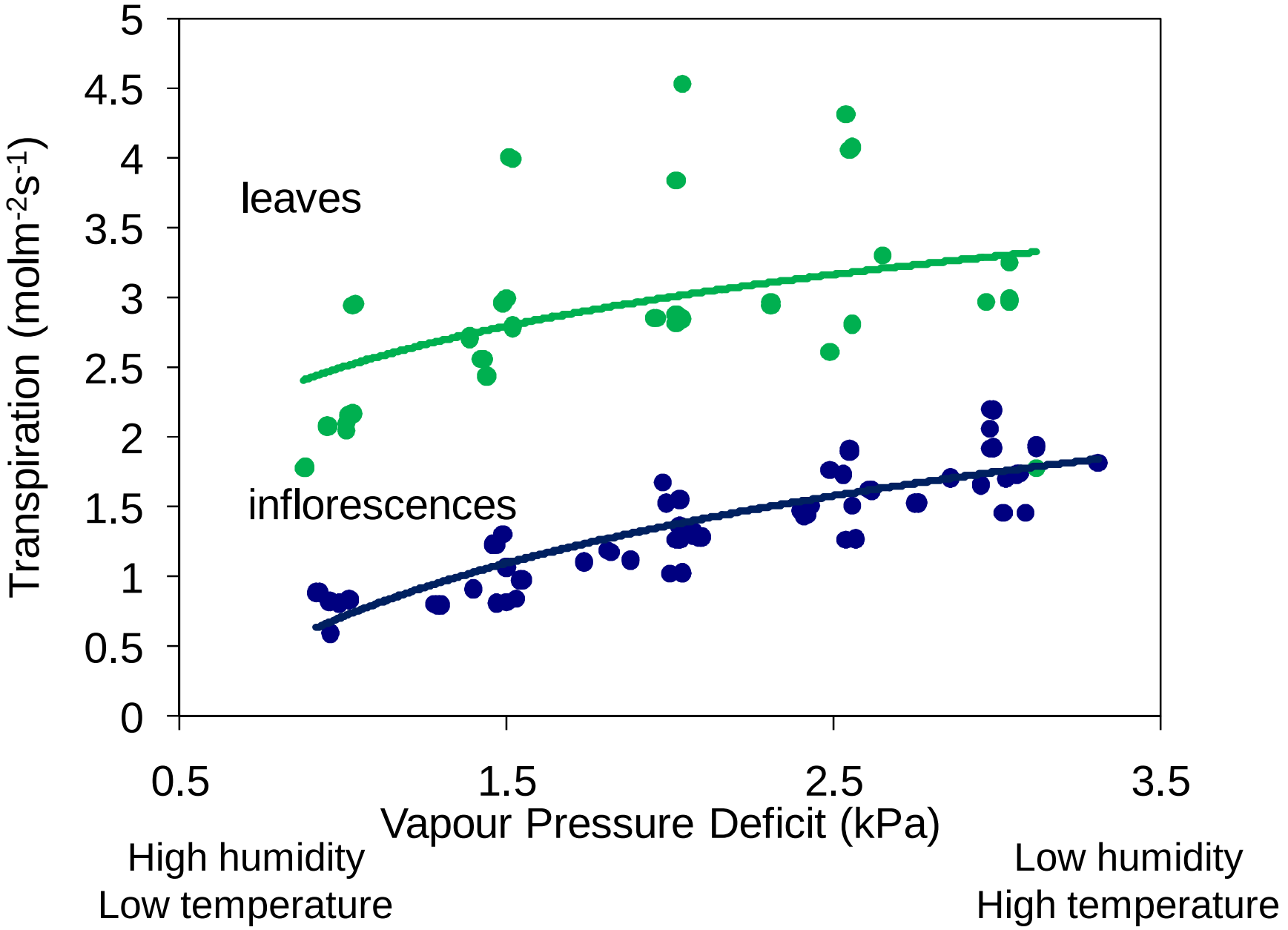
Stomatal response to humidity



High humidity
Low temperature

Low humidity
High temperature

Transpiration response to humidity

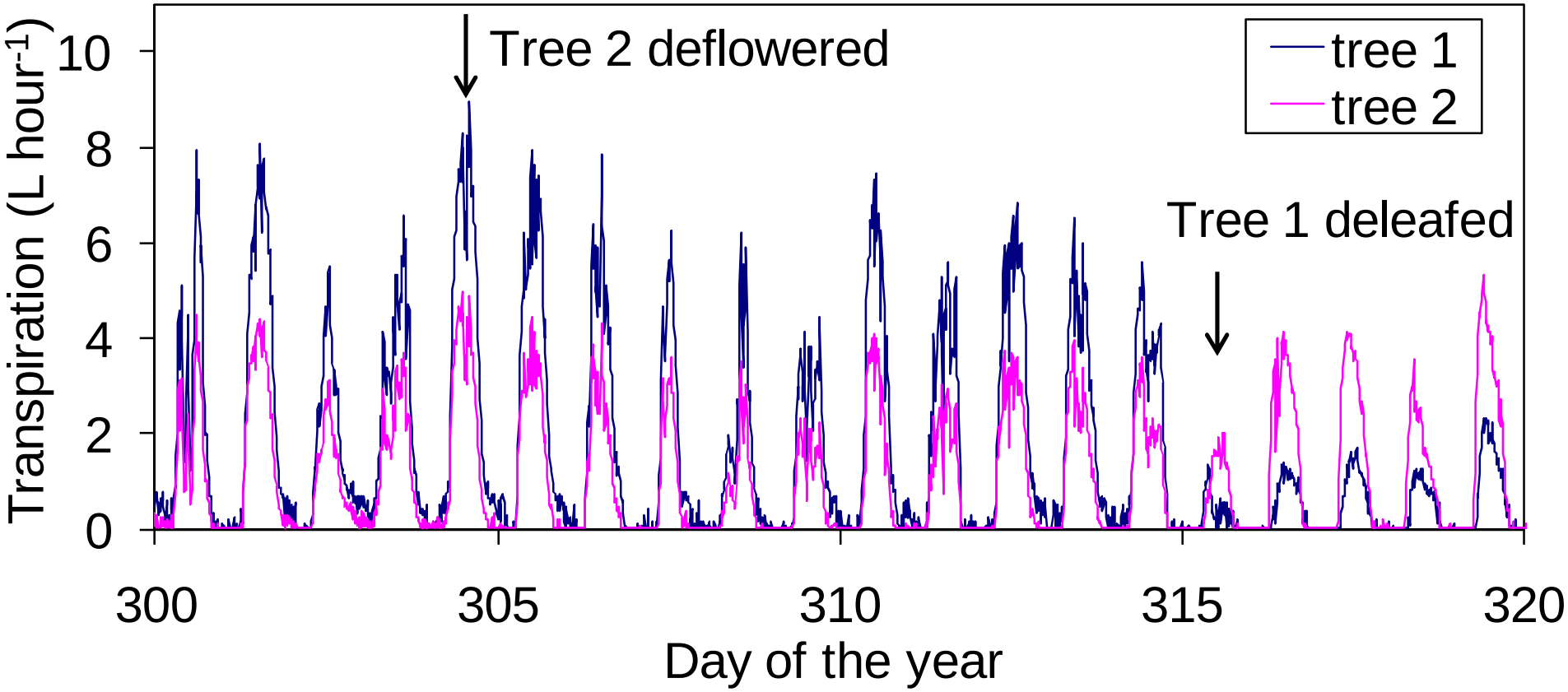


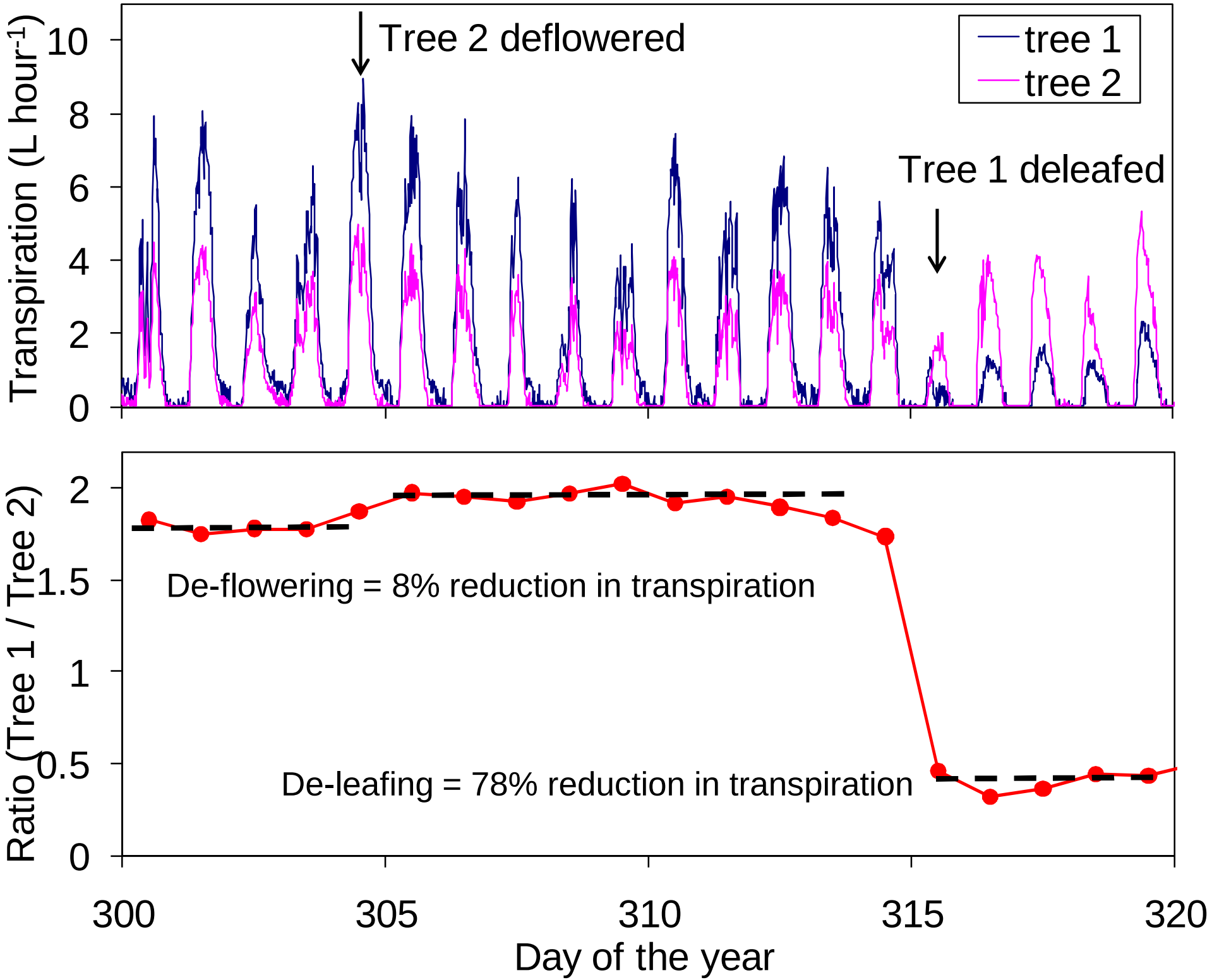
Measuring transpiration in the field

Heat pulse sap flow probes

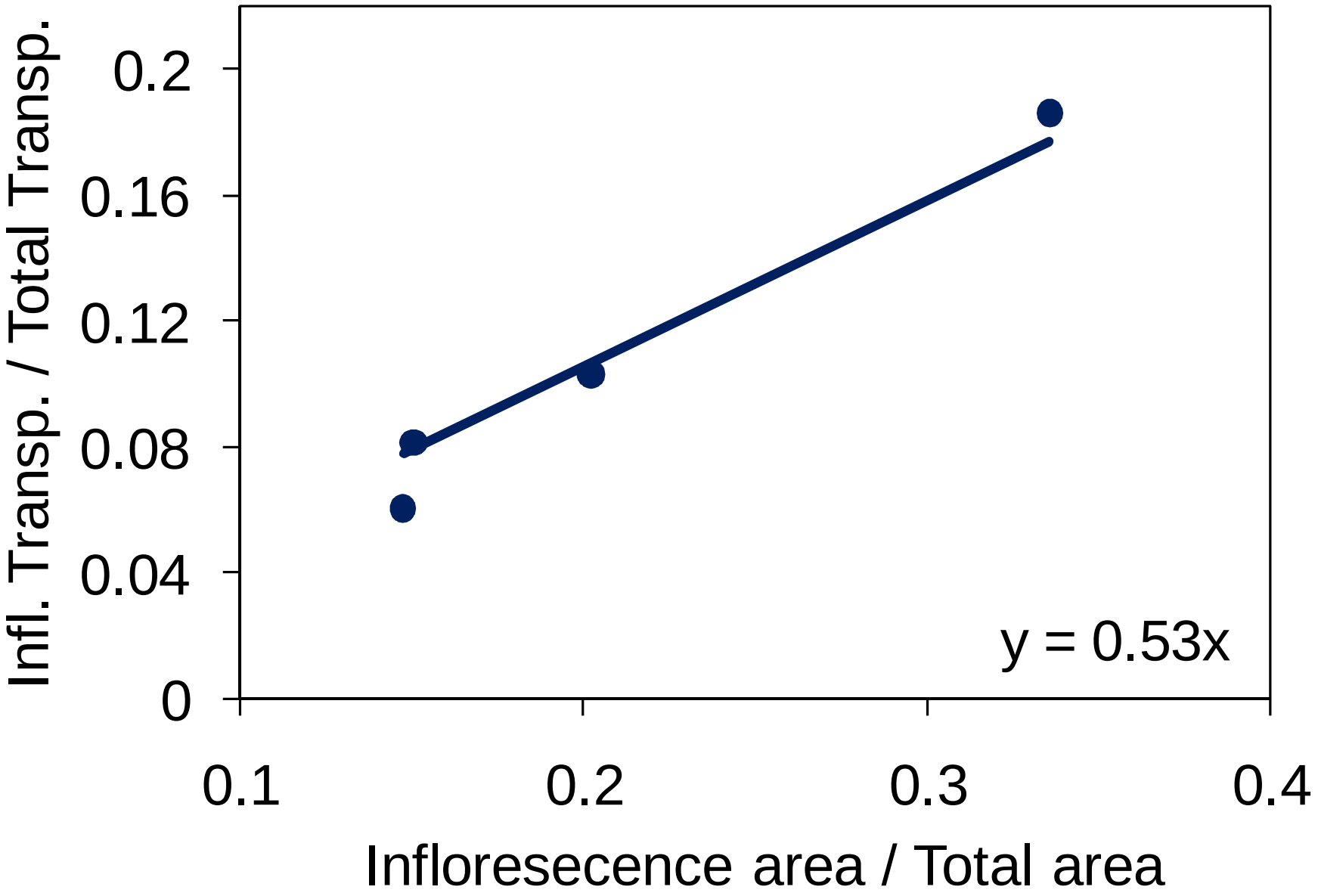
Paired branches, deflowering and deleafing

Transpiration from sap flow




Tree 2 deflowered
tree 1
tree 2
Tree 1 deleafed
Transpiration (L hour-1)
0
2
4
6
8
10
Ratio (Tree 1 / Tree 2)
0
0.5
1
1.5
2
De-flowering = 8% reduction in transpiration
De-leafing = 78% reduction in transpiration
300
305
310
315
320
Day of the year

Comparison – Area vs Transpiration



Soil moisture and plant water potentials

- Experiment conducted under mild conditions with adequate rainfall
- No significant decline in soil water content over flowering
- Plant water potentials and stomatal conductance were unaffected by flower removal, even with heavy flowering

Conclusions

- Inflorescences contribute up to 35% of the total transpirational surface area during flowering
- Inflorescence surface conductance is half or less that of leaves
- Inflorescences contribute up to 15% of the total transpirational water loss during flowering
- The flowers do not use 80% of the water, but soil moisture and irrigation management still matter
- Soil moisture deficits and tree water stress are unlikely to contribute to alternate bearing if carefully managed
- Flower water relations may still be a factor in fruit set

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