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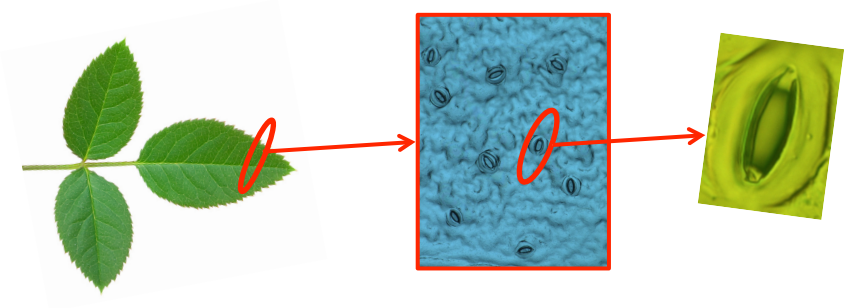
Effect of high humidity on stomata and its implication for (ornamental) plants quality



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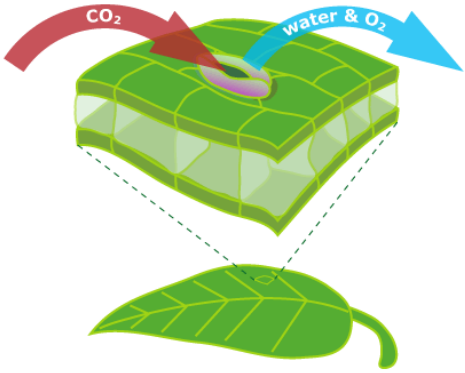
Stomata: adjustable pores on the leaf surface

loss of H_2O & CO_2 uptake occur in parallel



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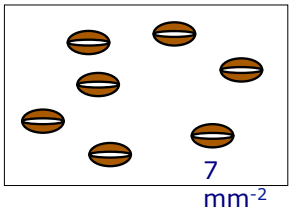
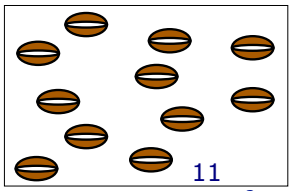
Environmental effects


Short-term (sec to hours), *reversible*: aperture

Long-term (days to weeks), *irreversible*: physiology (closing ability) & anatomy (size, density)





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Relative air humidity (RH)

% of max air water content (depends on air temperature)

Air holding capacity, 17.3 g H_2O m^{-3} air (20 ºC)

if ≥ 14.7 g m^{-3} are present: RH ≥ 85%

RH depends on moisture available and air temperature

Vapour pressure deficit (VPD) =

vapour $pressure_{saturated}$ - vapour $pressure_{actual}$

VPD characterizes the evaporative demand of air and is one of the key drivers of plant transpiration

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High humidity exists

- nature [tropical areas & nothern latitudes (winter)];
- protected cultivation [culture vessels for *in vitro* propagation/rooting of leafy cuttings & greenhouses (winter/spring and night)]
- The length high humidity period might vary



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High humidity - solutions

- High humidity (90%) leads to fungal disease, hence to prevent the rise of such high humidity vents will be opened so that the inside humid air is replaced by dryer outside air
- However, opening vents while heating increase energy consumption
- Therefore, humidity control is a compromise between avoiding very high RH and lowering the
- High humidity $\geq$ 80% & $\leq$ 90% as such may not lead to fungal disease but result in lower shelf life
- Air cons, dehumidifier and air exchange can solve the problems – at a cost

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Stomata developed at high RH (≥ 85%) show reduced stomatal closing ability

- After growth at high RH and transfer to conditions of lower humidity => loose much water
- Practical implication: reduced vase life in ornamental plants cultivated at high RH
- Cultivar-specific differences

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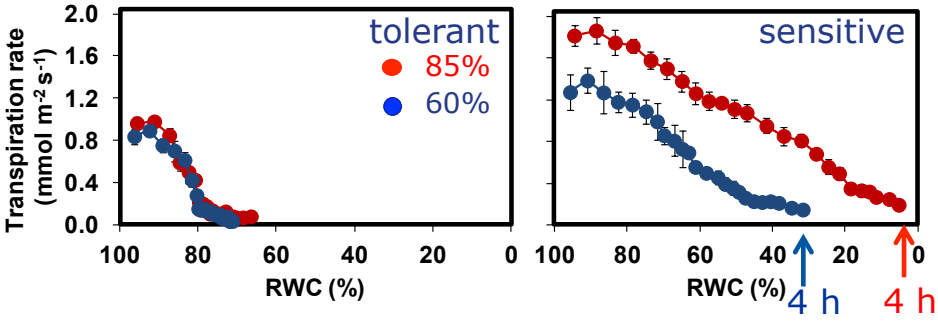
Stomatal response to desiccation



Relative water content (RWC)
By high RH leaves become more dehydrated (lower RWC 4 h)

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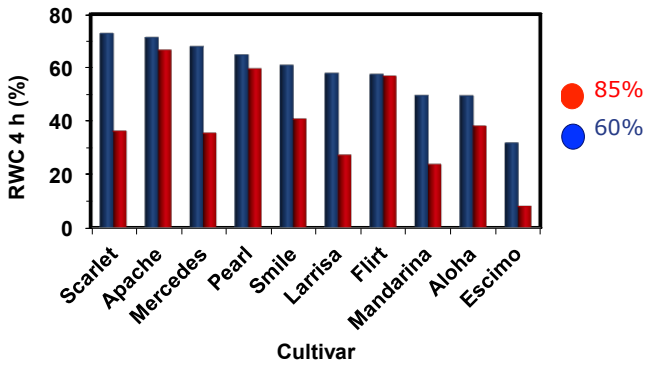
Stomatal response to desiccation: wide genetic variation in roses



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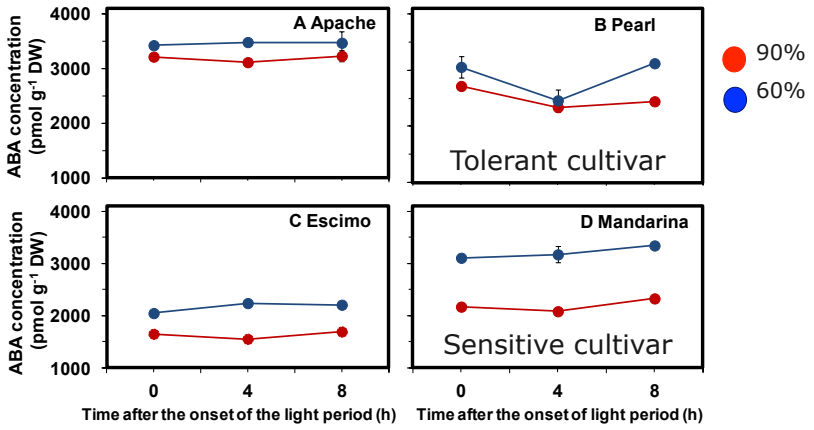
Leaf [ABA] at growth conditions



Leaflet [ABA] is lower at high RH

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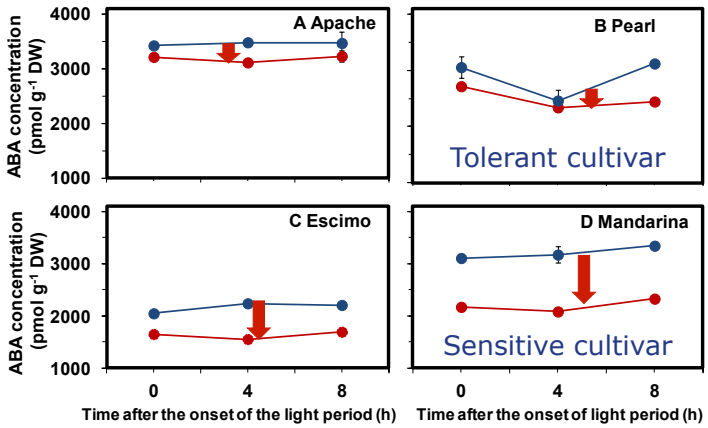
Why does the cultivars differ in stomatal responsiveness?



Differential decrease in [ABA]

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Summary

- The negative humidity effect on stomatal closing ability depends **on cultivars**
- The cause of cultivar difference is differential decrease in ABA
- Stomatal responsiveness can be improved by adjusting the humidity level or increasing air temperature (increases costs of heating)
- Screening for tolerant cultivars are easy
- Selection of tolerant cultivars might be the solution

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A new approach to control humidity is in the pipeline

How do we modify climate control systems to control humidity and save on the heating costs based on understanding the stomatal regulation?

- Testing alternative dehumidification system (e.g. internal dehumidification using heat exchangers, ventilated latent heat converters)
- Or just allow the humidity to stay high for a bit longer
- Or lowering the humidity a bit

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A new approach to control humidity is in the pipeline – how..

- How long time can the plants tolerate the elevated humidity (and which humidity)
- Can we make the stomata more responsive
- Simple models for regulation
- Understanding of the metabolites (small molecules) turnover involved in regulation of stomatal opening and closing
- Roses, Kalanchoe and Chrysanthehum are main species

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