Effects of Plant Age and Genetic Modification on Fine-Scale Xylem Anatomy and Drought Tolerance in Tomato

Anai Pereira-Zaldivar, Giovanni Bortolami, Jan Van den Bulcke, Toon Gheyle, Iván Josipovic, Louis Verschuren, Gijs van Erven, Ellora Basu, Marian Bemer, Kailash Pandey, Gabrielle de Jong, Salma Balazadeh, Frederic Lens

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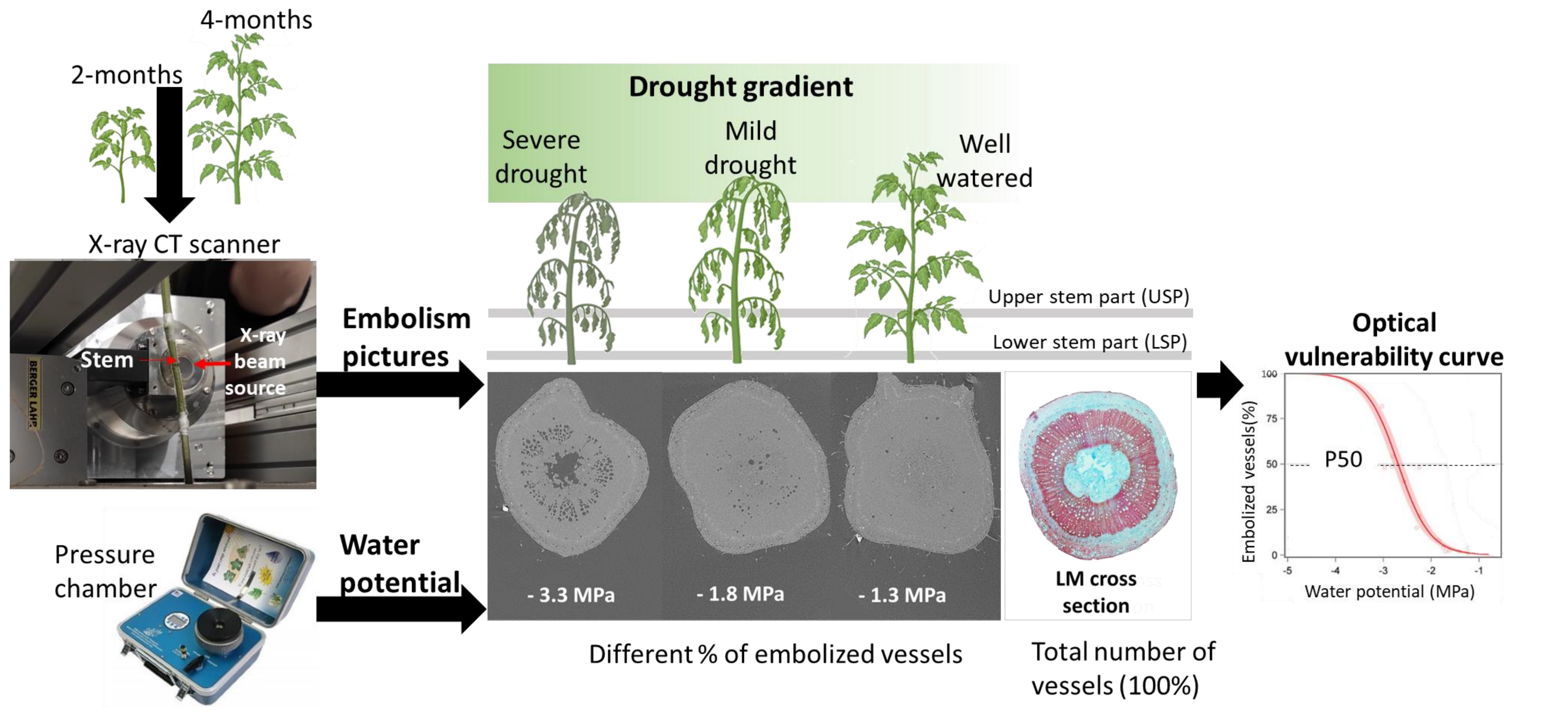
1 Background

Drought reduces soil water availability and lowers plant water potential, increasing the risk of xylem embolism that could potentially lead to plant mortality [1]. Embolism resistance is often quantified by the water potential at 50% loss of hydraulic conductivity (P_{50}). Drought resilience also depends on stomatal regulation, which determines how quickly plants reach P_{50} [2]. While stem embolism resistance is often linked to xylem anatomy, including fine-scale xylem traits, the role of developmental changes in these traits remains poorly understood in herbaceous crops [2,3,4]. In our study, we tested whether genetic modification (partial knockouts) of flowering time-inducing genes SOC1 and FUL and/or plant developmental stages affect drought tolerance by altering stem xylem proportion (P_{XYL}) and changes in intervessel pits and lignin monomer composition (Syringyl vs. Guaiacyl proportion = S:G) in the stem using three tomato genotypes.

2 Methods

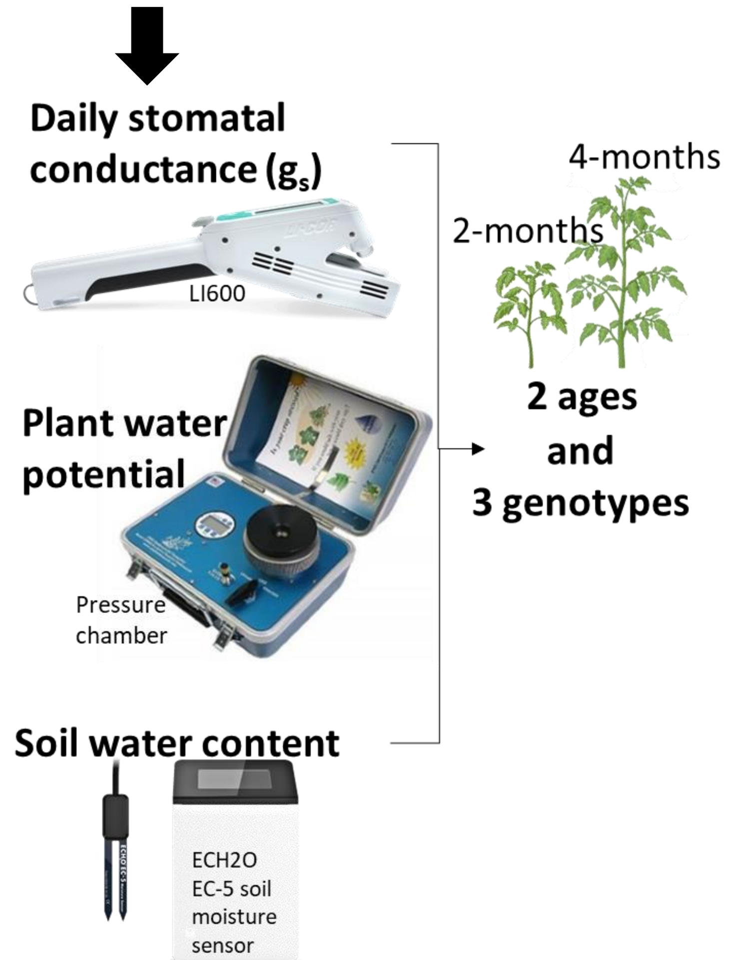
2.1. Stem vulnerability to drought-induced embolism (P_{50}) with Micro CT

3 genotypes: *Solanum lycopersicum* var. Moneyberg (WT), SOC1-like double and FUL SOC1-like quadruple mutants.

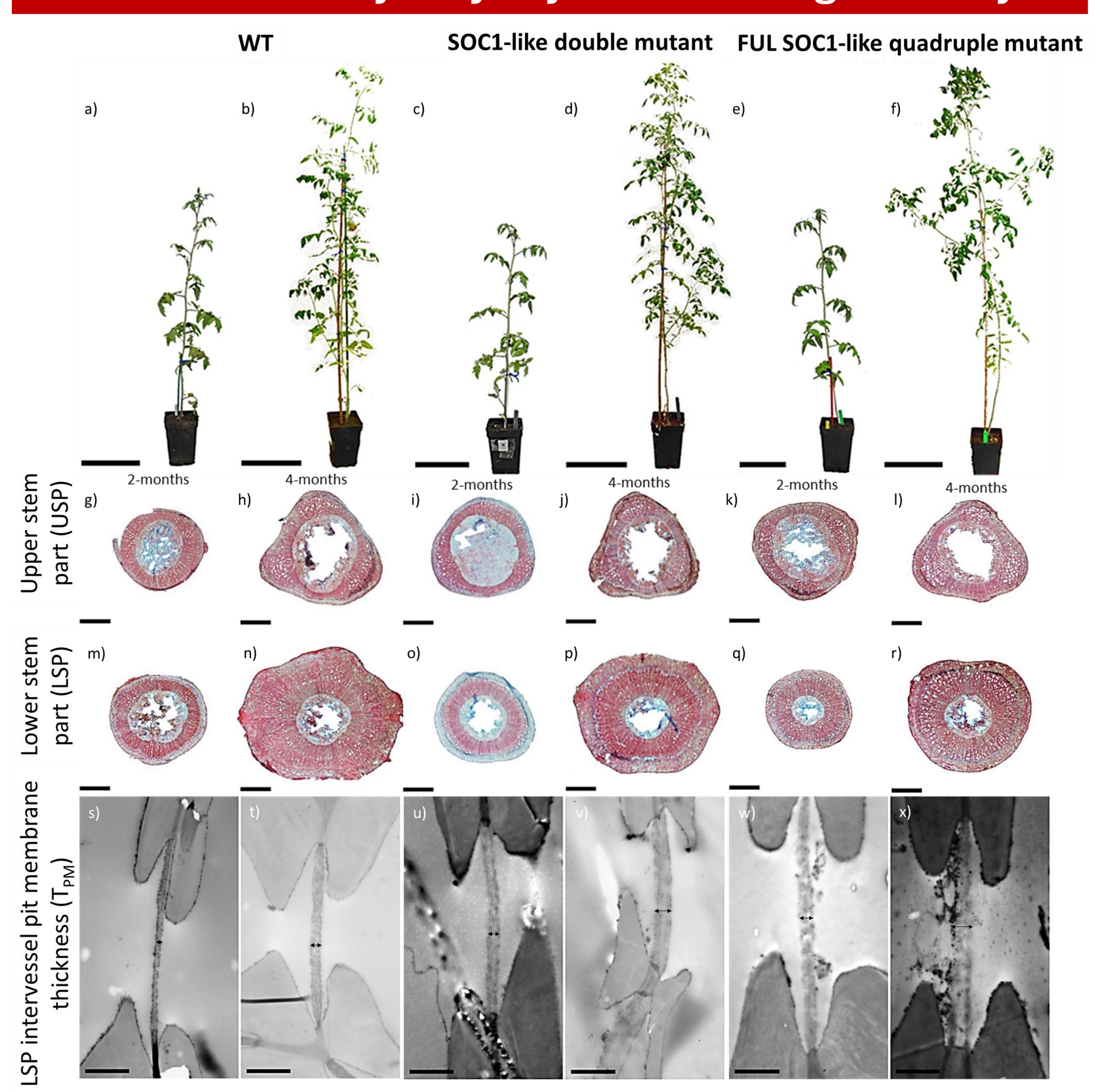


2.2. Drought experiment

Daily monitoring (16 days): control and drought treatment

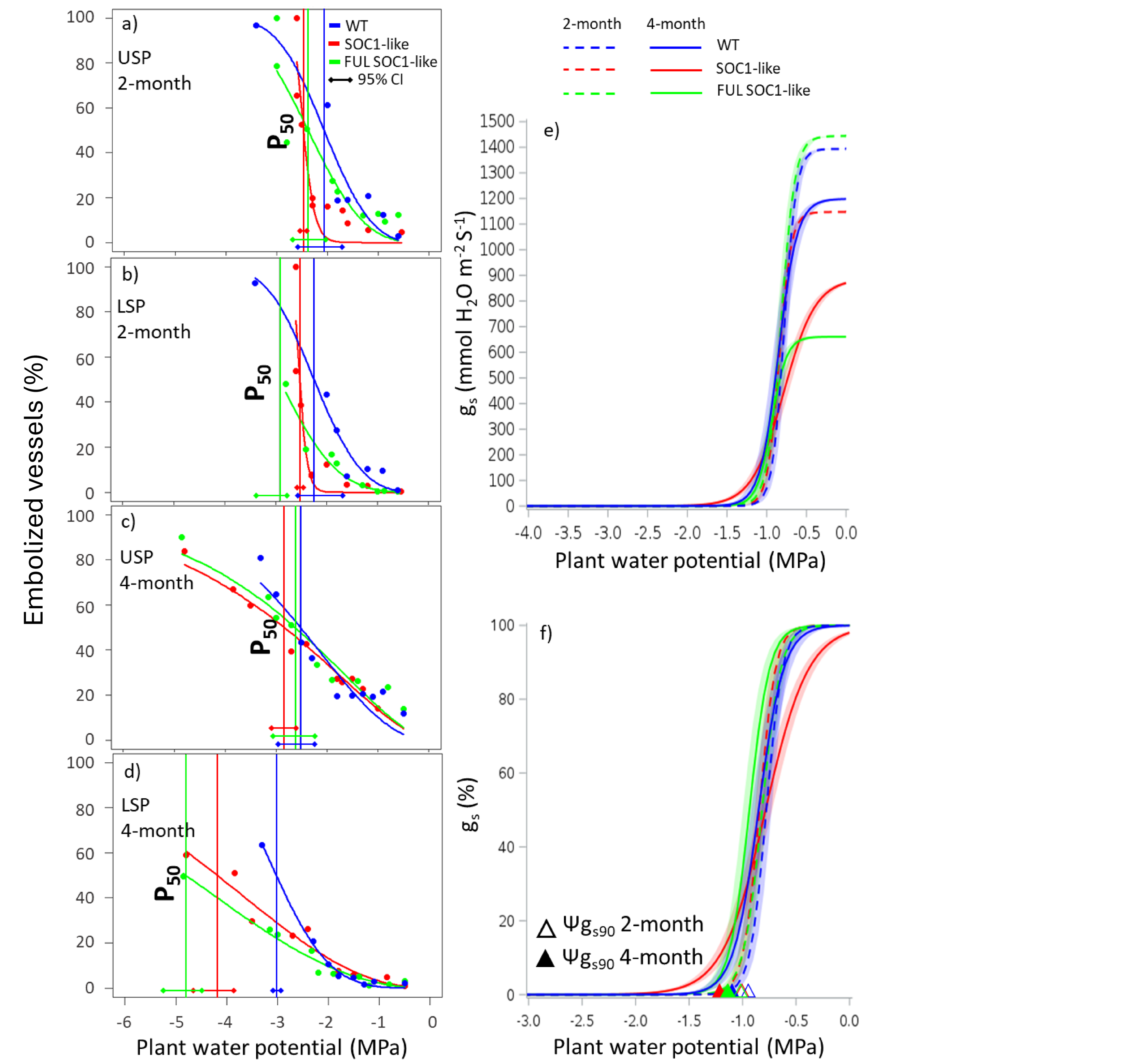


2.3. Stem anatomy & Pyrolysis-GC-MS lignin analysis

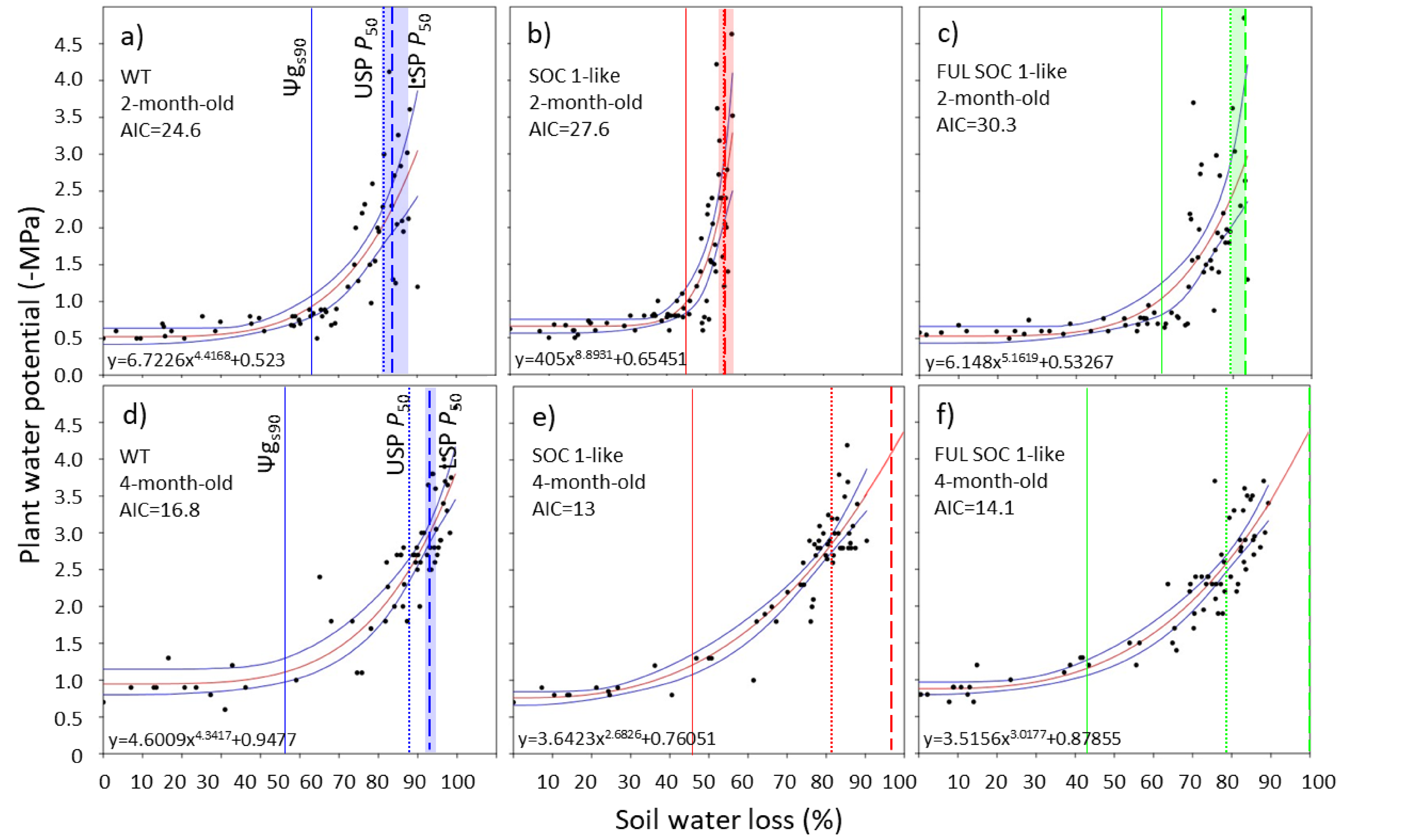


Results

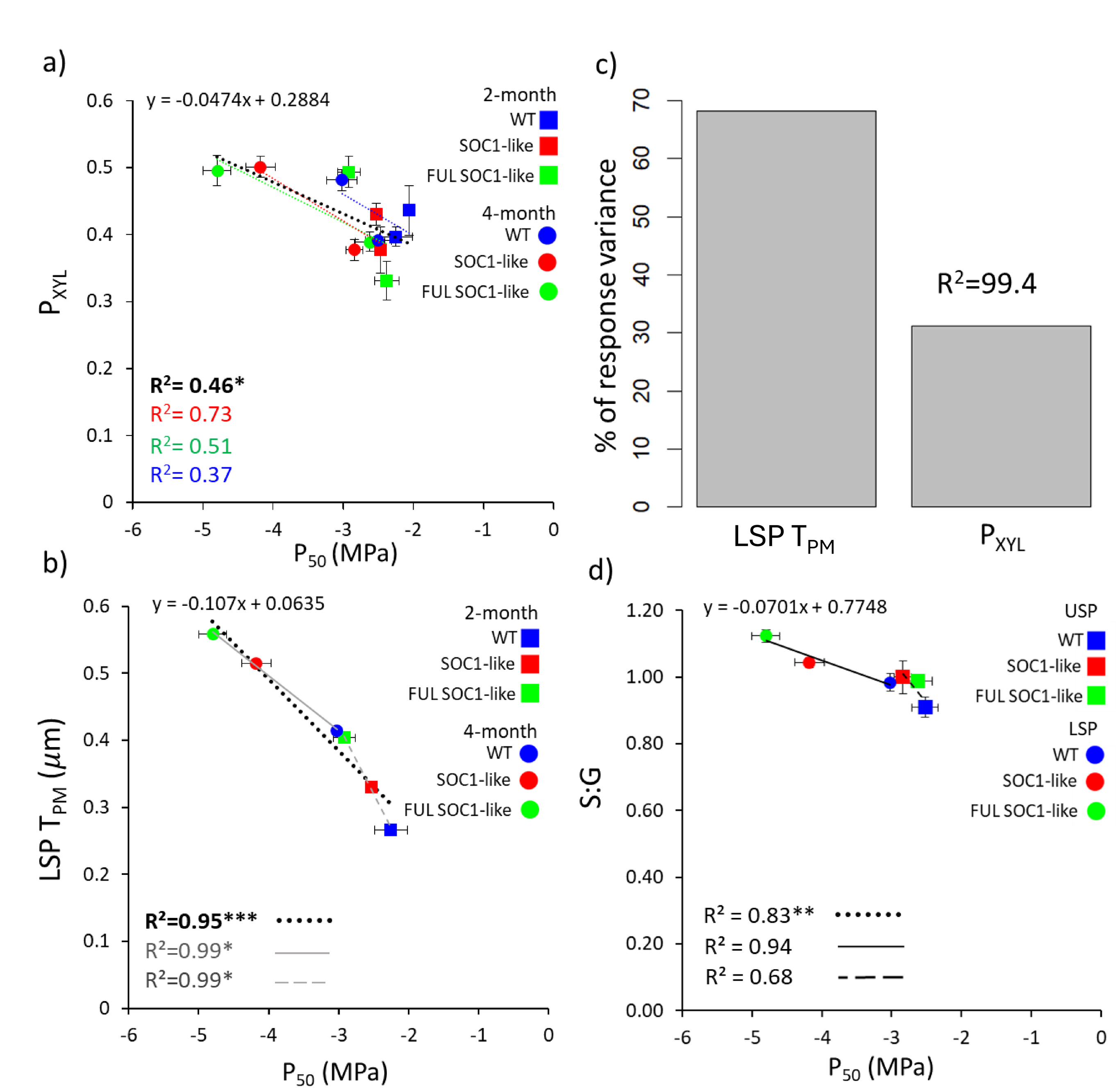
3 Stem P_{50} and stomatal behavior during drought



4 Hydraulic thresholds and water potential decline with drought



5 Stem xylem anatomy and lignin composition (S:G) traits explaining P_{50}



6 Take-home message:

1. Plant ageing and increased stem woodiness enhanced tolerance to drought-induced embolism and overall plants' drought tolerance.
2. FUL SOC1-like mutations increased overall drought tolerance.
3. Stem P_{50} and woodiness account for differences in drought tolerance between the different plant ages and along the stem within individuals, while intervessel pit membrane mainly determines differences among genotypes.
4. A higher proportion of S lignin monomer (higher S:G) accounts for higher embolism resistance and drought tolerance.

Contact:
Anai Pereira-Zaldivar
Ph.D. student
Anai.Pereira@naturalis.nl

More on my research at Naturalis here:

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References

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