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Differential contribution of free and esterified jasmonates in plant stress responses

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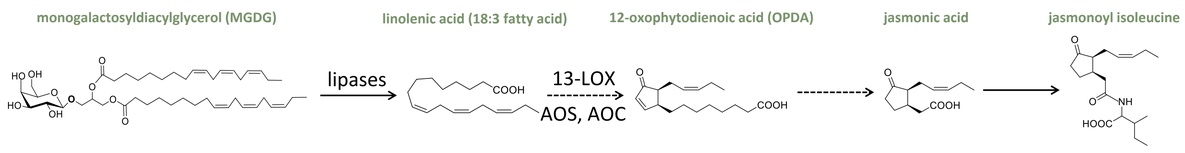
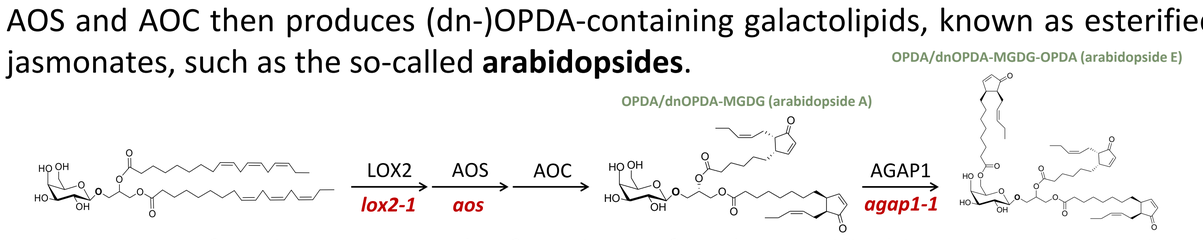
Introduction

Jasmonates are **plant hormones** derived from **lipid oxidation** that play critical roles in plant development and stress responses. They result from galactolipid hydrolysis into fatty acids, before oxidation of these fatty acids by lipoxygenases (13-LOX). Oxidized fatty acids are then transformed into JA precursors, called (dinor-)**12-oxophytodienoic acid** ((dn-)OPDA), by the subsequent action of AOS and AOC enzymes. (Dn-)OPDA is then converted into the well-known **jasmonic acid**, which can be further derived into its bioactive form **jasmonoyl isoleucine** for instance.



However, among 13-LOX, the LOX2 isoform is also able to directly oxidize fatty acyl chains within galactolipids. Further processing of these oxidized fatty acyl chains by AOS and AOC then produces (dn-)OPDA-containing galactolipids, known as esterified jasmonates, such as the so-called **arabidopsides**.

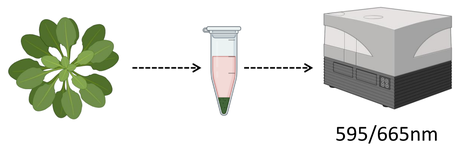


In contrast to free jasmonates, the functions of such esterified jasmonates remain up to date largely hypothetical and poorly understood. In this context, our work aims to **decipher the functions of free jasmonates versus esterified jasmonates** in the stress responses of the model plant *Arabidopsis thaliana* (L.) Heynh, using a reverse-genetics approach and phosphorus (P) deficiency as a case study.

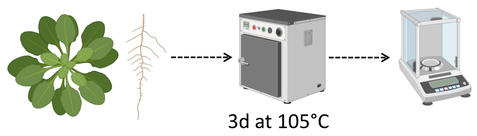
Material and methods

4 *Arabidopsis* plant lines with differential contents in jasmonates (wt, *lox2-1*, *aos*, *agap1-1*) were cultured in hydroponics for 7 weeks (= 5 weeks +P and 2 weeks +/-P) before harvest and analysis of their P starvation responses.

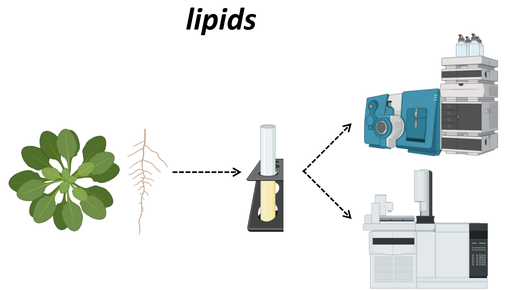
anthocyanins



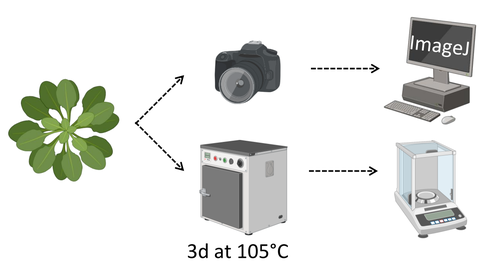
root-to-shoot ratio



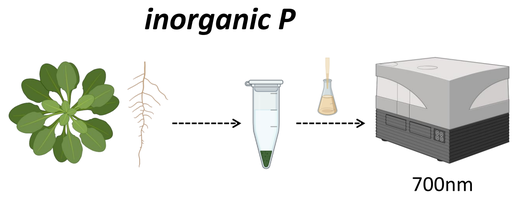
lipids



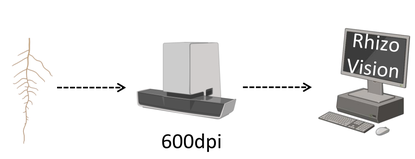
leaf specific area



inorganic P



root architecture



Results and discussion

Results show that during P deprivation and compared to the wt, the ***aos* mutant** displays significantly:

- **Lower anthocyanin accumulation** (A),
- **Higher root inorganic P content** (C),
- **Lower root development** (H, J-M).

In contrast, the *lox2-1* and *agap1-1* mutants do not generally differ significantly from the wt. With regards to their differential alterations in the biosynthesis of jasmonates, this would indicate that while jasmonates partially control responses to P deprivation, this regulation seems exerted by **free jasmonates** specifically.

Meanwhile, P deprivation significantly impacted glycolipid composition, leaf inorganic P levels, root sterol and suberin contents (B, D-G), but there were little to no significant differences between wt and *aos.* This suggests little to no involvement of jasmonates, whether free or esterified, in these P starvation responses. The same was observed for specific leaf area (I).

Perspectives

Several P starvation responses in *Arabidopsis*, like anthocyanin accumulation, seem to be controlled by free jasmonates. This may perhaps notably occur at a transcriptional control. Indeed, the *aos* mutant displays a higher content in inorganic P in roots, despite a lower root development compared to the wt. This would suggest an effect of jasmonates on the gene expression of P-related transporters, although this remains to be explored.

Whereas this study reveals functions of free jasmonates in P starvation responses, the involvement of esterified jasmonates seems very limited. Further work should explore whether esterified jasmonates act at a much more local level e.g., in chloroplasts where they are produced.

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