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Biostimulation of grapevine and wheat : mode of action and possible agronomic uses

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Evidence for foliar uptake of sulfated laminarin into grapevine depending on surfactant use and leaf surface.

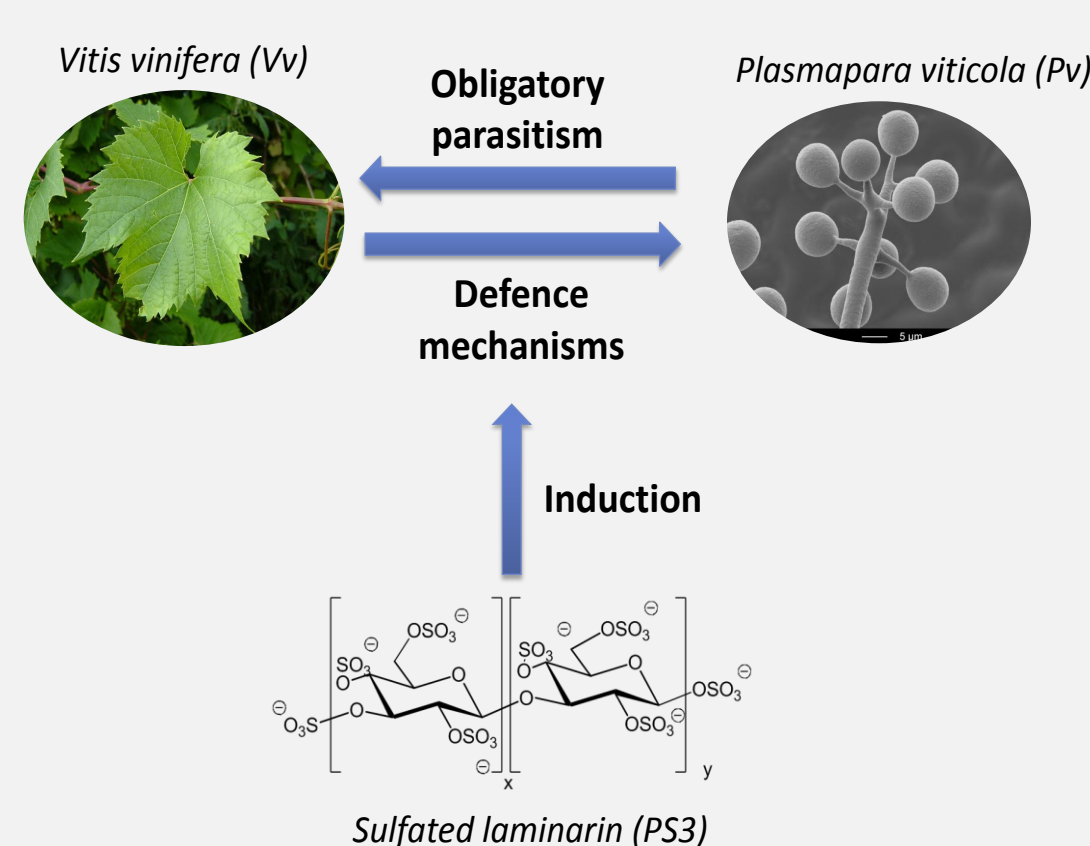
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Context

THE PATHOSYSTEM

- **GRAPEVINE** : Perennial crop with major economic and cultural value, but susceptible to many cryptogamic diseases such as downy mildew.
- **DOWNY MILDEW** : Disease caused by the biotrophic oomycete *Plasmopara viticola* (Pv), responsible for considerable damages in worldwide vineyards : loads of fungicides are required.

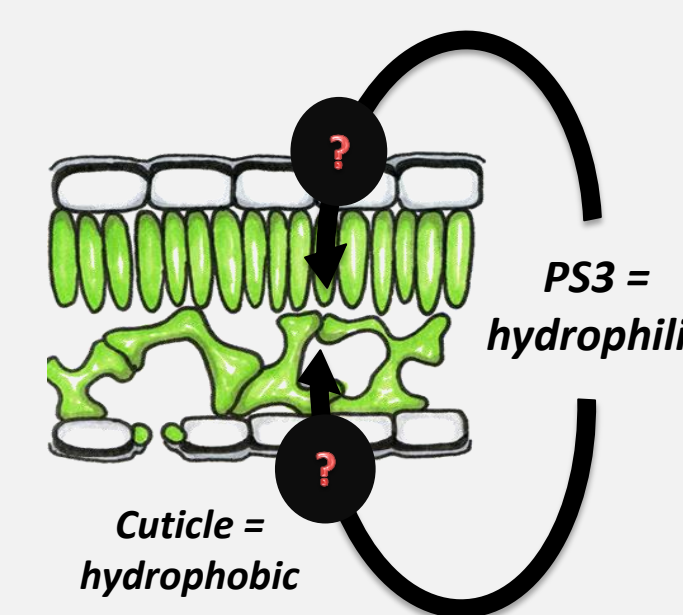


ELICITORS : A PROMISING CONTROL STRATEGY

- **ELICITORS** : Compounds able to trigger plant defences, resulting in some cases, in an enhanced resistance to bioaggressors. Some oligosaccharides (OS) like β -glucans are elicitors (Delaunoy *et al.*, 2014).
- **SULFATED LAMINARIN (PS3)** : Obtained by chemical sulfation of laminarin, a β -(1,3)glucan from the brown algae *Laminaria digitata*. PS3 was shown to elicit plant defences and to induce resistance against Pv in controlled conditions (Trouvelot *et al.*, 2008).

...UNFORTUNATELY ENCOUNTERING MANY BARRIERS.

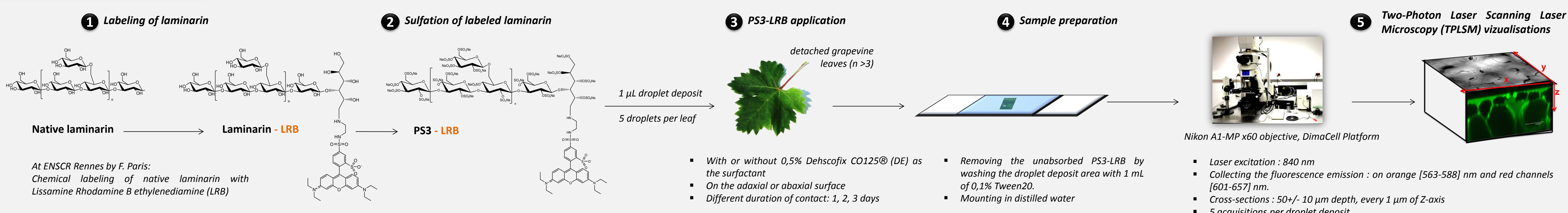
- Disease control by OS is often inconsistent. Elicitors' efficacy depend on many factors (Walters, 2013), including their bioavailability.
- One hypothesis is that hydrophilic elicitors with high MW (>1000Da), such as PS3, have to cross the hydrophobic cuticular barrier, to reach internal receptors.



AIMS
Understanding the uptake of PS3 in grapevine leaves, to improve its protection rate against Pv by:

- (1) Developing a method to visualize its penetration *in planta*
- (2) Studying the effect of an ethoxylated surfactant use and influence of leaf surface.

Developing the method



RESULTS

- Observation 1 -

Better uptake of PS3-LRB when formulated in an adequate surfactant than in water.

- Observation 2 -

Better uptake of PS3-LRB with DE into the abaxial foliar tissue than into the adaxial one.

- Observation 3 -

Preferential uptake of PS3-LRB along the anticlinal cell walls and especially through stomata.

- Observation 4 -

In bioassays, PS3 in DE reduces the sporulation of Pv by 20 to 30%, compared to PS3 in water.

DISCUSSION

In the literature, surfactants were shown :

1. to promote the uptake of a range of hydrophilic compounds such as glucose derivatives (Forster, 2005).
2. to increase the water content of cuticle, and consequently to improve leaf permeability to water-soluble compounds (Ramsey, 2005).

This could be due:

1. to the fact that grapevine possesses stomata on the abaxial surface only
2. to the difference in waxes and cuticular structure and composition between its leaf surfaces

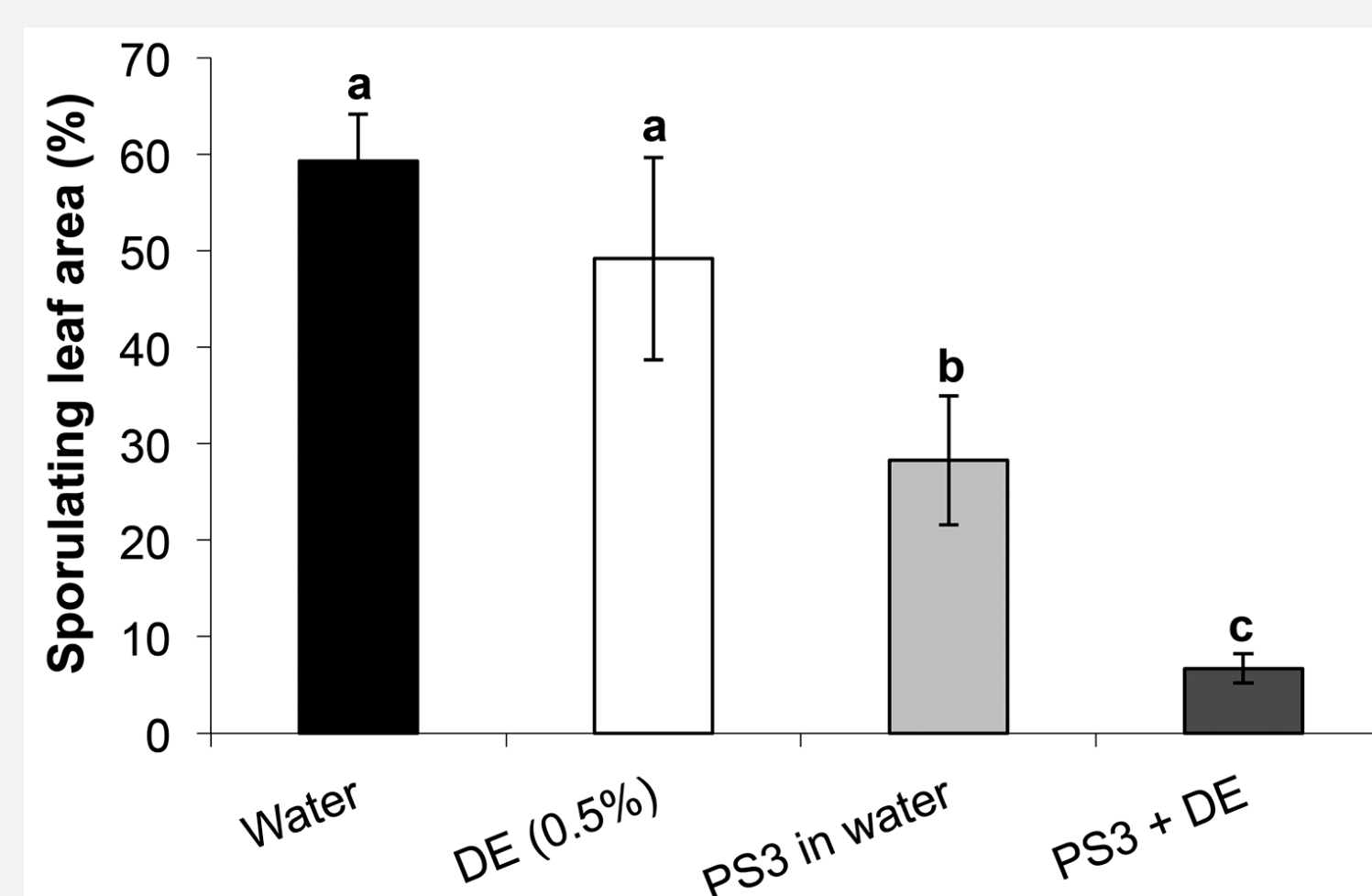
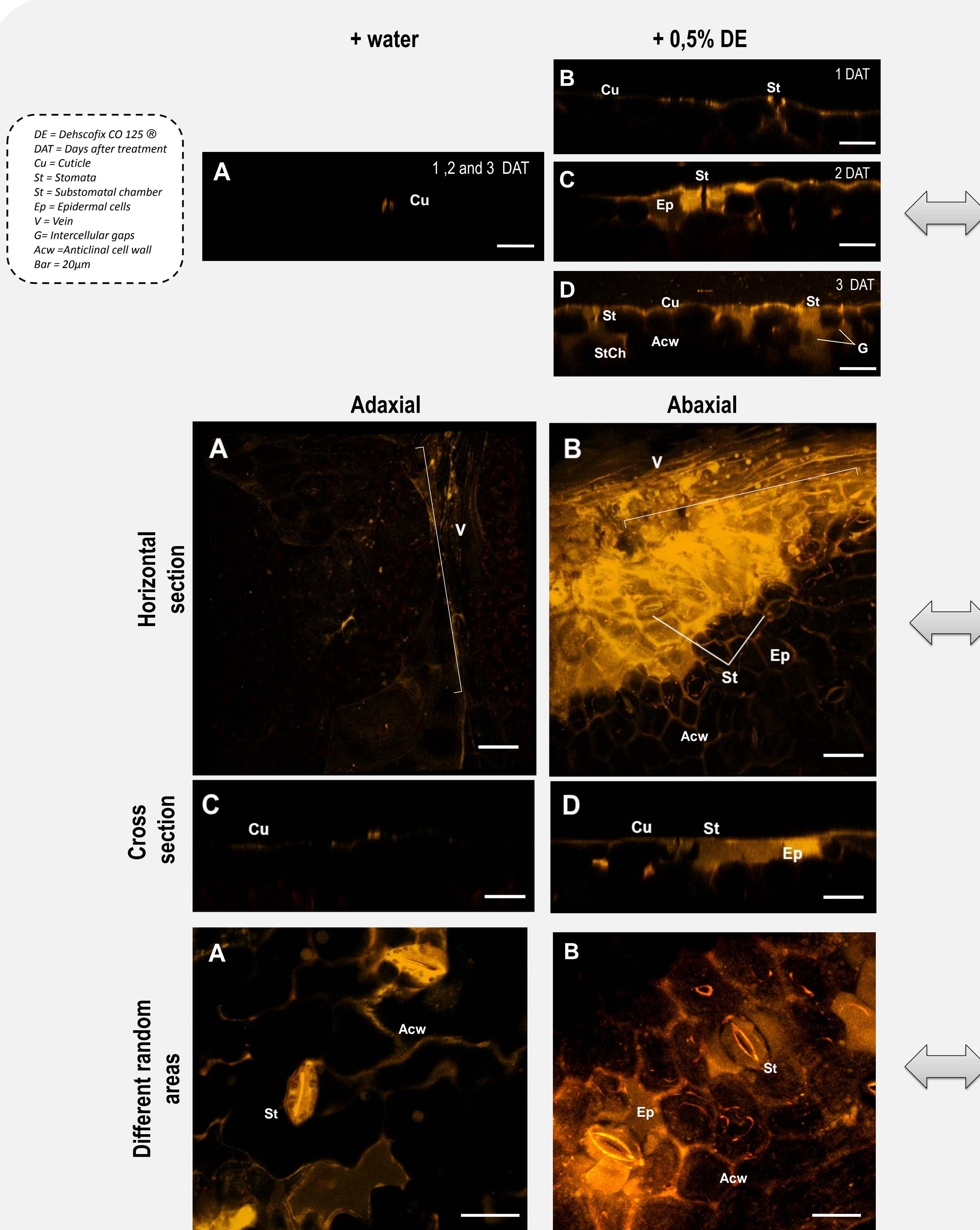
→ Therefore, further studies should focus in analyzing differences in the thickness and composition between the two leaf surfaces*.

Hydrophilic compounds can enter the leaf via polar pathways in the cuticle. They consist of polysaccharide fibers embedded in the cuticle.

These polar zones were shown to occur preferentially in the cuticle above anticlinal cell walls, around the stomata and at the bases of trichomes (Schönherr 2006).

The beneficial effect of DE on PS3 uptake into grapevine leaf is backed by increased PS3-induced resistance in these biological tests.

→ This supports our hypothesis that insufficient bioavailability of OS elicitors can limit their efficacy.



Take-home messages

1. The development of this microscopic observation method enabled us to show that an OS elicitor such as PS3 does not readily enter the grapevine leaf without an *ad hoc* formulation.
2. Spray application of OS elicitors preferentially targeting the abaxial surface of the grapevine leaves may improve the effectiveness of such treatments.

* Want to know more? See our online publication: Paris *et al.* (2015) An ethoxylated surfactant enhances the penetration of the sulfated laminarin through leaf cuticle and stomata, leading to increased induced resistance against grapevine downy mildew. *Physiologia plantarum*. doi: 10/1111/ppl.12394