EFFECT OF OZONE POLLUTION ON THE CHEMICAL SIGNAL EMITTED BY A MEDITERRANEAN TREE TO ATTRACT ITS SPECIFIC POLLINATOR

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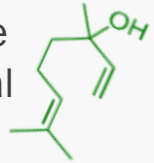
Human health

Respiratory problems
Threshold = 120 ppb/3h
Lippman, 1991

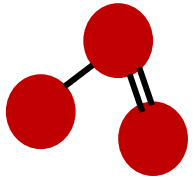
Vegetation

Oxidative damage to leaves
Threshold = 100 ppb/1h
Black et al., 2007

Impact on the emission of Volatile Organic Compounds (VOCs) by plants that are fundamental for plant-insect chemical communication
Yuan et al., 2009



O_3



Thresholds above which the oxidative potential of the tropospheric ozone (O_3) affects biotic interactions have been neglected in most studies and in the European Directive (2008/50/EC) of 14 April 2008.

VOCs in the atmosphere

Reduction of the lifetime of VOCs in the atmosphere and production of secondary VOCs
Atkinson & Arey, 2003

Degradation of the chemical signal emitted by plants and possible effects on plant-insect interactions

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What is the impact of O_3 pollution on a plant-pollinator interaction ?

We expect that troposheric O_3 affects each step of the plant-pollinator chemical communication :

O_3

Signal emission by the plant → Chemical signal in the atmosphere → Attraction of the pollinator

Study system : The mediterranean fig tree *Ficus carica* and its obligatory and specific pollinator

Oviposition site

Ficus carica

Blastophaga psenes

Pollination

Receptive figs emit 4 VOCs in proportions that attract *B. psenes* (Proffit *et al.*, 2020)

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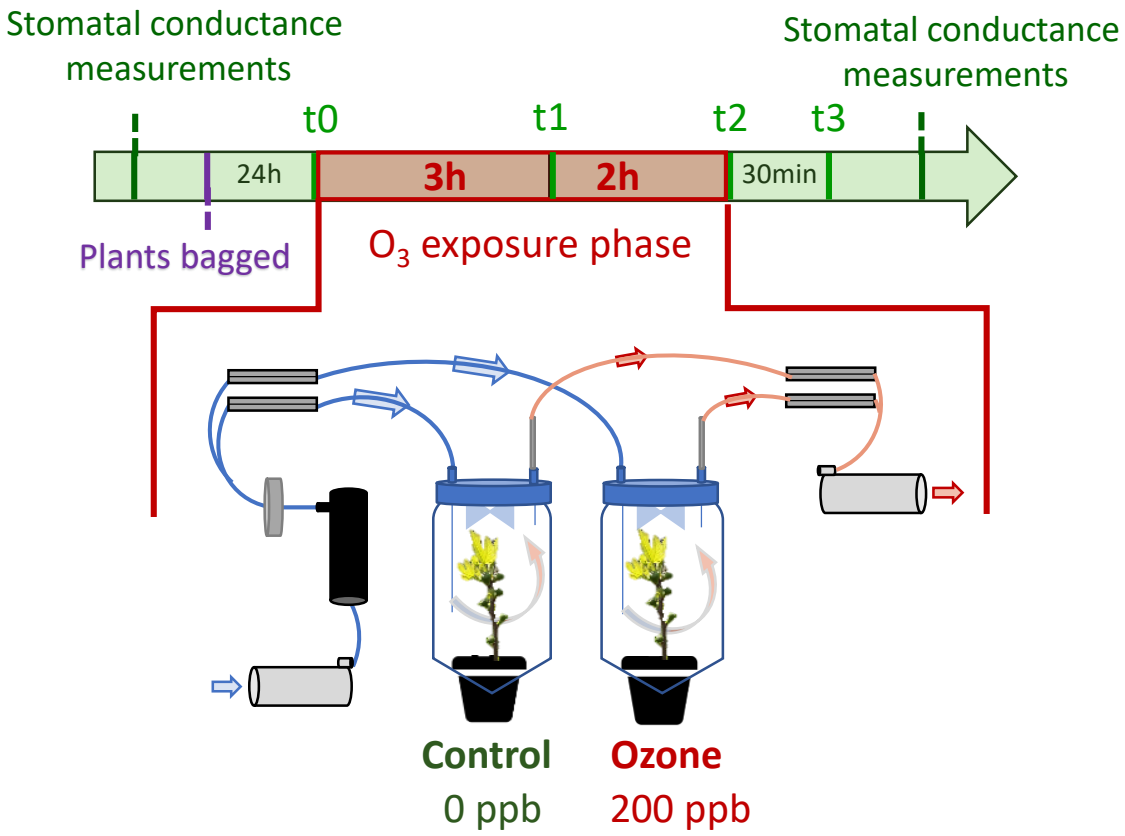
Impact of O_3 on the VOCs emission by the plant



- Exposure of **pairs of fig trees to 0 and 200 ppb of O_3** during 5h to simulate a quite realistic pollution peak (On summer 2003 at Marseille an [O_3] concentration of 208 ppb was measured)
- **VOCs collections** were conducted in the two chambers **at different times** : **t0** (Before the exposure), **t1** (3h of exposure), **t2** (5h of exposure) and **t3** (30min after shutting down the exposure) and analysed by Gas Chromatography Mass Spectrometry (**GC-MS**)
- Measurement of the plant response to the oxidative stress by **comparing the stomatal conductance before and after O_3 exposure**

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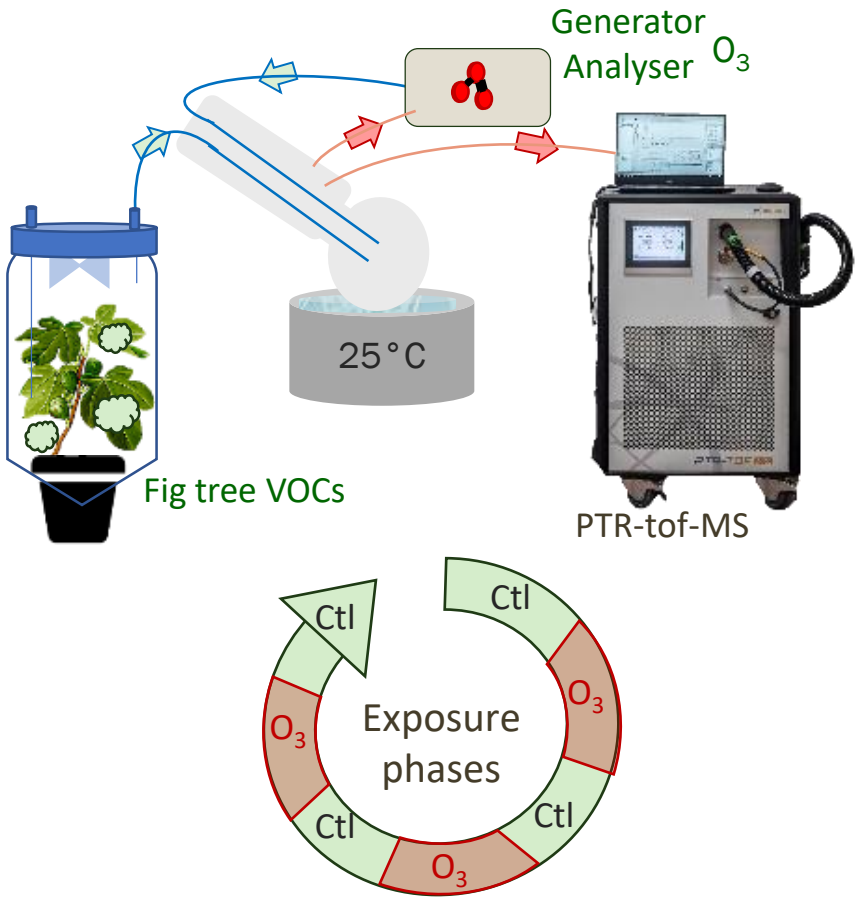
Impact of O_3 on the lifetime of VOCs emission in the atmosphere

- Proton Transfer Reaction-time of flight-Mass Spectrometer (**PTR-tof-MS**) recordings of **VOCs isolated in a reaction chamber and exposed to "control/O_3" phases**
- **Comparisons of VOCs concentrations with and without O_3** in the reaction chamber in real time.
- **Identification of VOCS formed by the reaction** between VOCs and different concentrations of O_3



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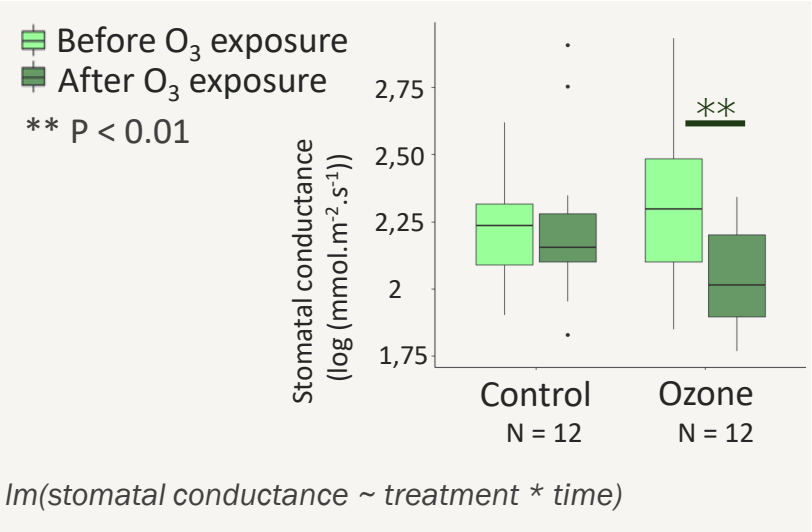
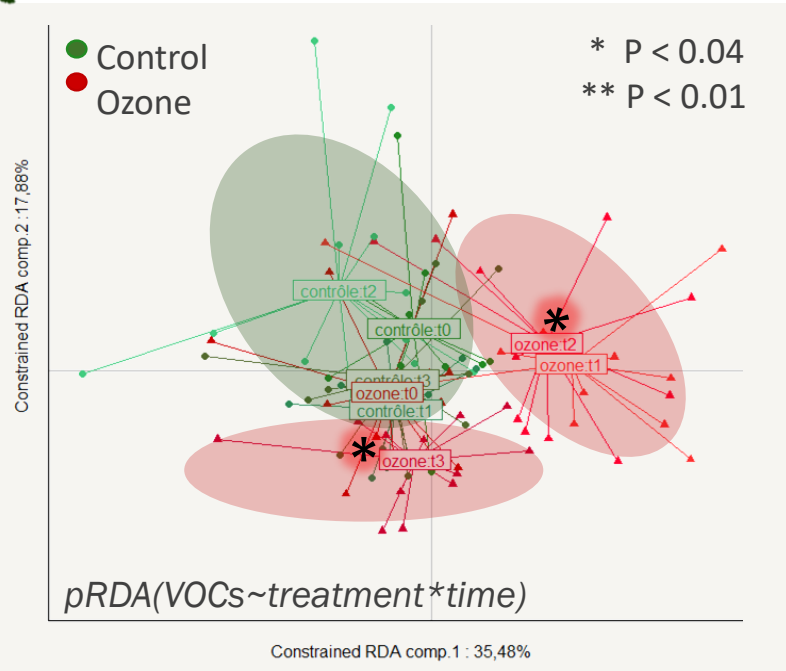
Impact of O_3 on the fig tree physiology



Plant response to a high concentration of O_3 = stomatal closure

Impact of O_3 on the fig tree VOCs emission



During O_3 exposure → Concentrations of some VOCs vary and some new VOCs are formed.

When there is no longer O_3 in the chamber (t3) → emissions are still different from "control" emissions and from "ozone t1" and "ozone t2" emissions.

O_3 affects :

→ the plant's physiology by inducing stomatal closure

→ the plant by a change in its VOCs emission

→ identity and quantity of fig tree VOCs by the reaction with O_3 provoking the alteration of the chemical signal

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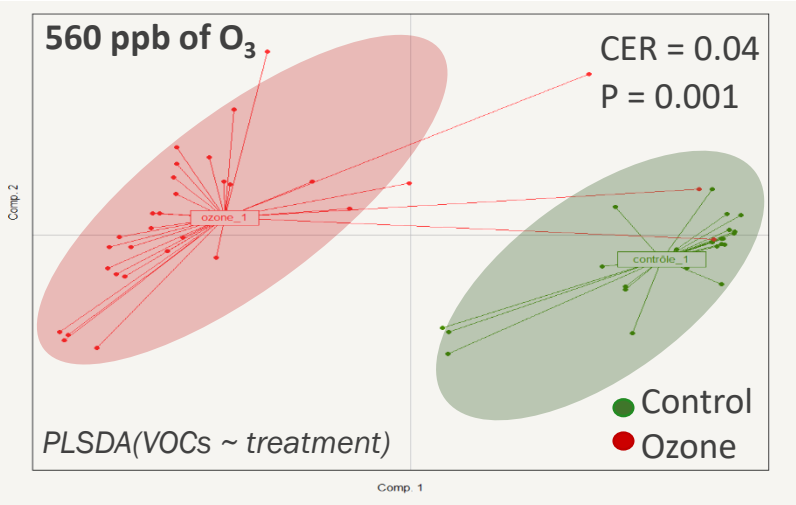
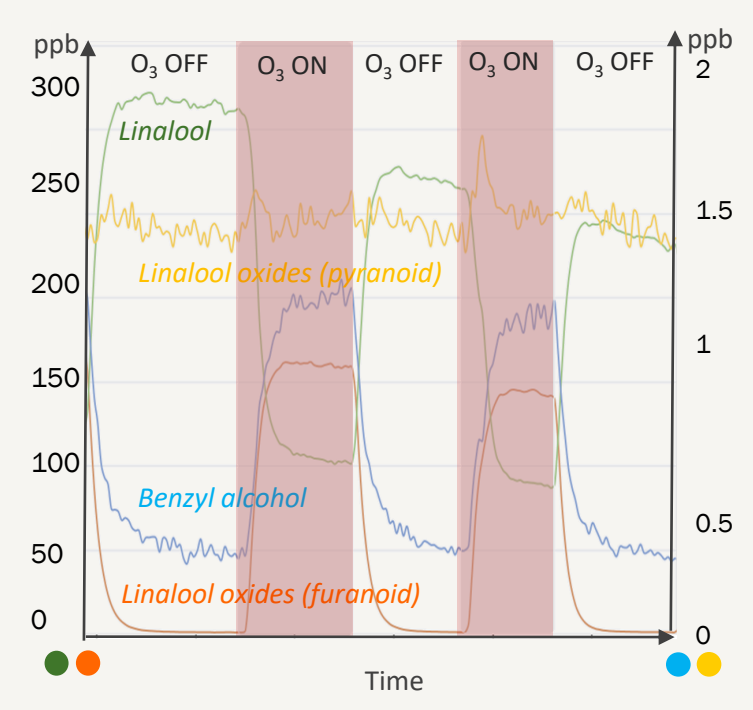
Impact of O_3 on the VOCs plume



Under high [O_3] → formation-degradation of VOCs

New VOCs that are in part products of reactions of linalool with O_3 (Atkinson & Arey, 2003) → Lavender lactone, methylglyoxal, formic acid, acetone and formaldehyde

Impact of O_3 on the VOCs responsible for pollinator attraction



During O_3 exposure → Concentrations of the VOCs responsible for pollinator attraction follow different patterns and we know that **the attraction of the pollinator is inhibited** when the proportions of these compounds are modified (Proffit *et al.*, 2020).

Linalool and linalool oxides (furanoid) on the left axis and linalool oxides (pyranoid) and benzyl alcohol on the right axis

These results indicate that :

→ The VOCs emitted by fig trees react differently with O_3 in the atmosphere

→ As a consequence proportions of VOCs change dramatically

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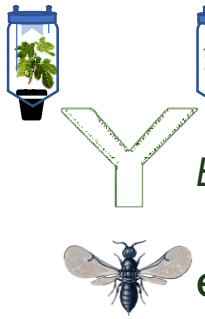
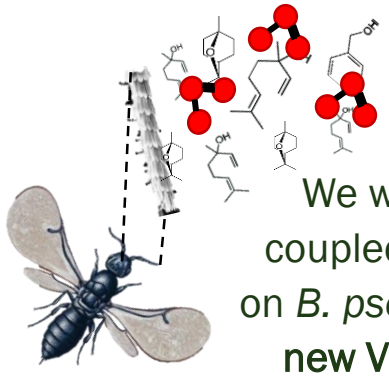
Med 2020

Context | Objectives & Study system | Methods | Results Part I | Results Part II | Conclusion & Perspectives

Control **Ozone**



We want to couple Y olfactometer tests on *Blastophaga psenes* and O_3 expositions of fig trees to **evaluate the pollinator behavior when the plants are exposed to O_3, changing the proportions of the VOCs**



We want to perform Gas Chromatography coupled with Electroantennography Detection on *B. psenes* antenna to **determine which of the new VOCs formed with O_3 the pollinator can detect**

References & Funding

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