



EUROPEAN
FUSARIUM
SEMINAR

June 12-15, 2023
ROME, ITALY
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SAPIENZA
UNIVERSITÀ DI ROMA

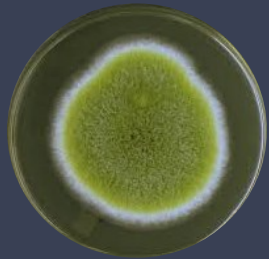
Fungal volatile organic compounds: new tools to reduce mycotoxin contamination in crops?

Laurie Josselin – PhD





25% of the world's foodstuffs are contaminated with mycotoxins



⇒ Aflatoxins

Aspergillus sp.



⇒ Fumonisin

Fusarium sp.



⇒ Patulin ...

Penicillium sp.



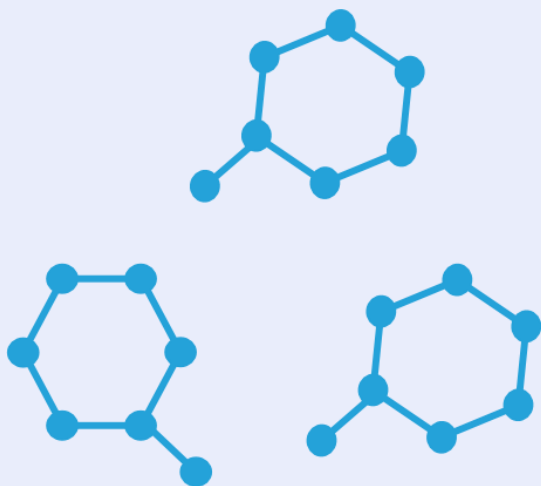
/! Sanitary control



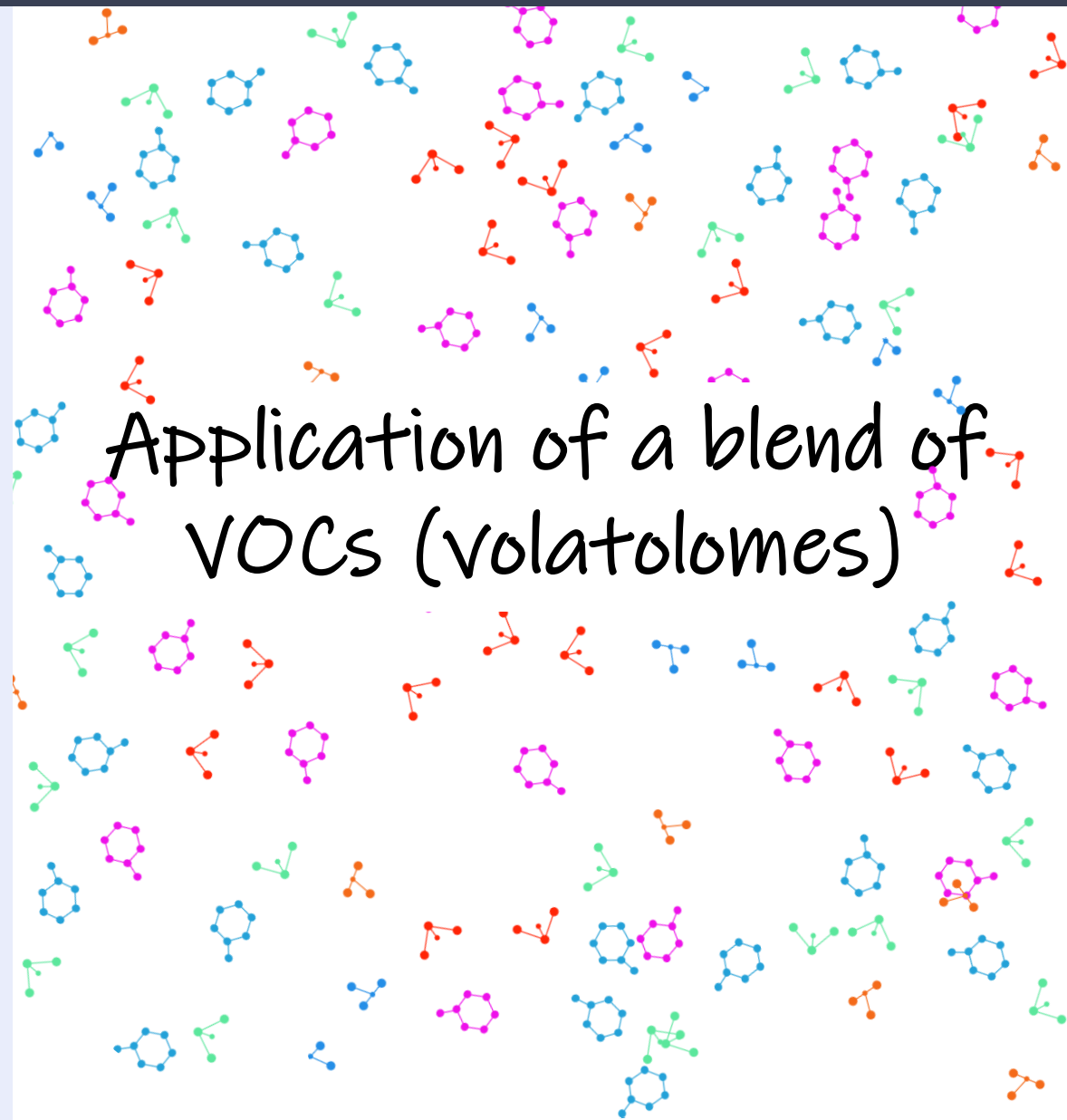
Control method

- ▶ Crop rotation
- ▶ Pesticides: fungicides
- ▶ Good Agricultural Practices (GAP)
- ▶ Post-harvest management

Application of a single VOC

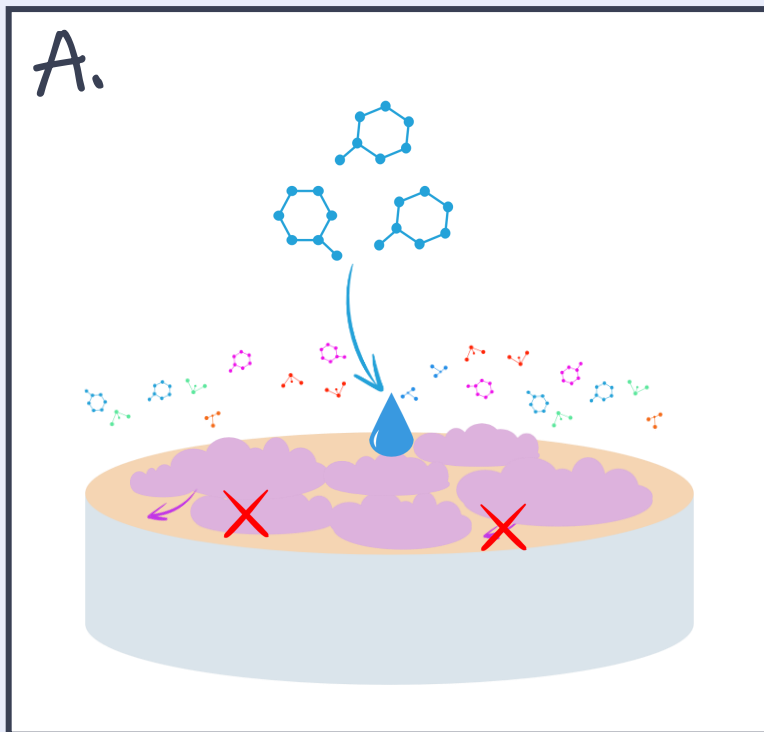


Application of a blend of VOCs (volatolomes)





Application of a single VOC



...on MEA

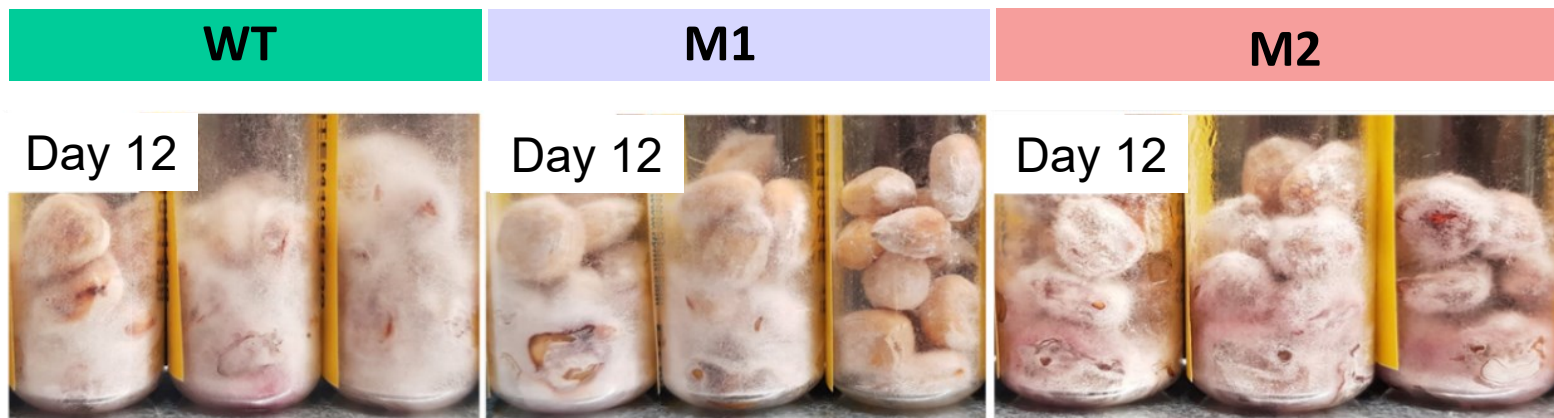


...on maize

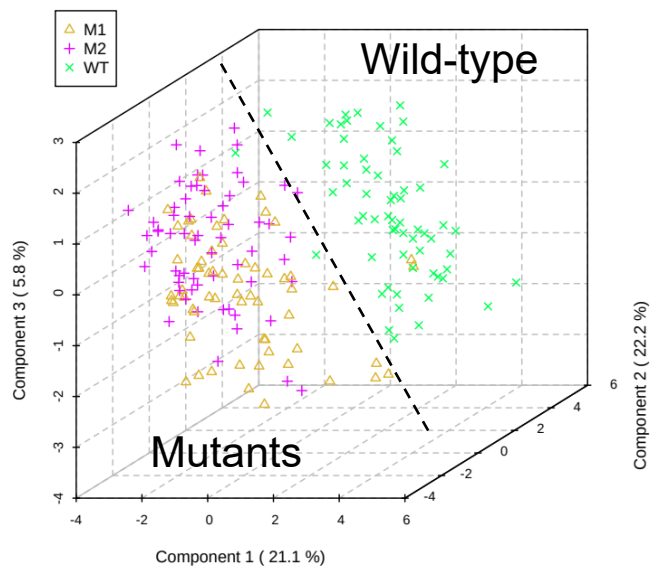
Application of a blend of VOCs (volatolomes)



Previous work based on *F. verticillioides* and its genetic mutants ...



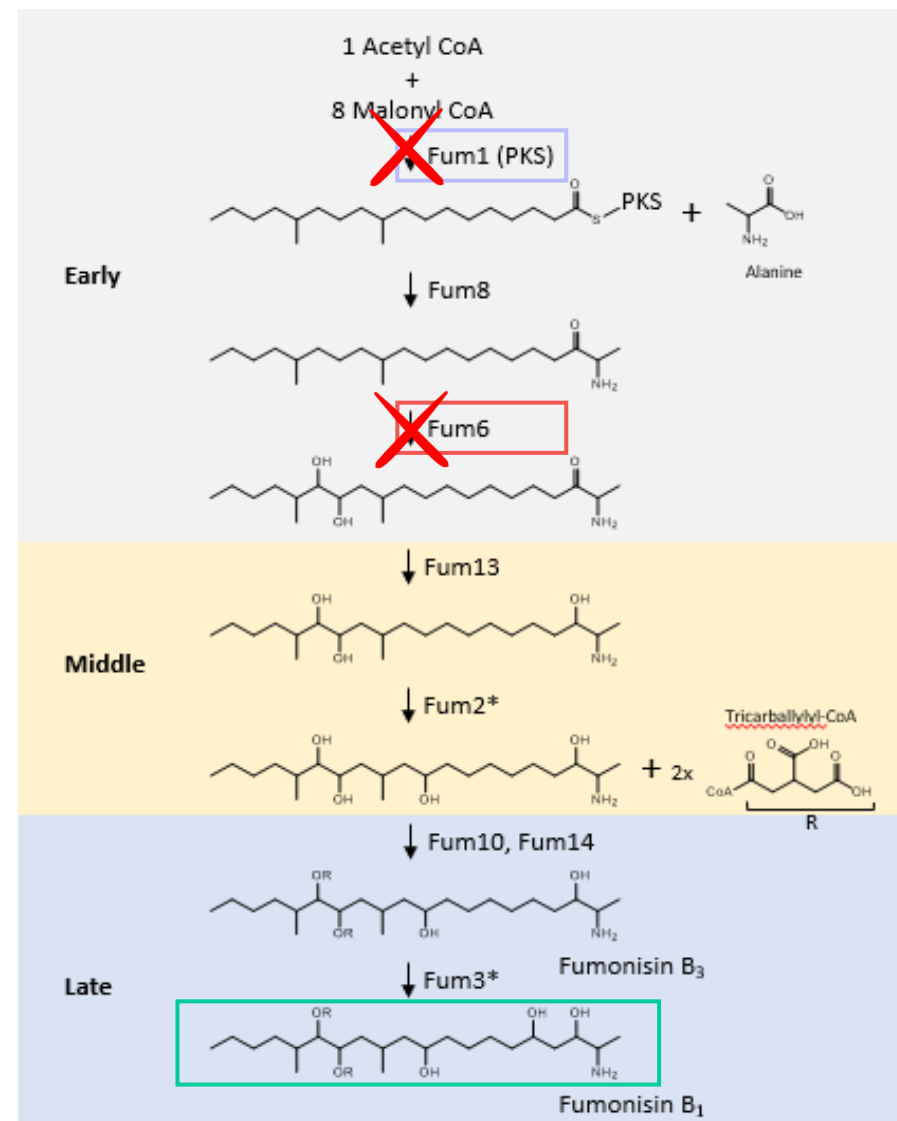
Fungal development of three strains of *F. verticillioides*: ITEM 10514 (WT), ITEM 10515 (M1), ITEM 10516 (M2)



- ▶ Ethyl 3-methylbutanoate
- ▶ Ethyl butanoate
- ▶ Ethyl 2-methylbutanoate
- ▶ Ethyl 2-methyl propanoate

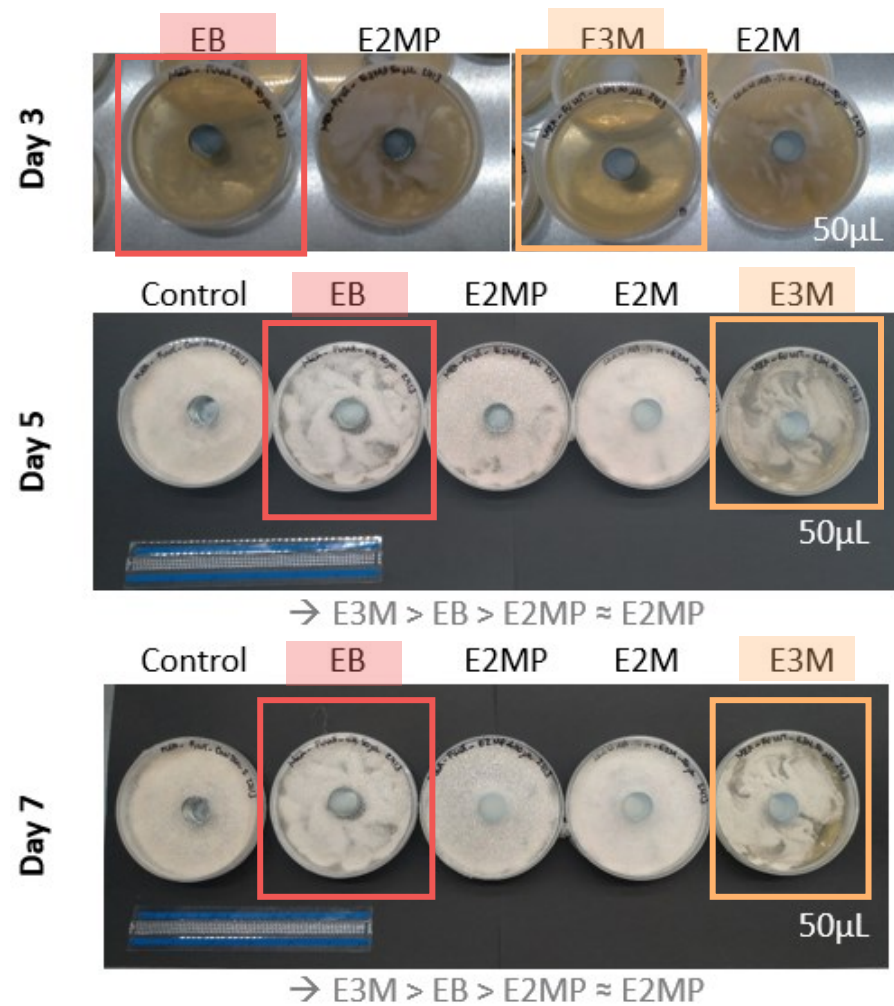
↓

All mutants specific VOCs



PLS-DA on the 3 kinetics for wild type (WT), Mutant 1 (M1) Mutant 2 (M2)

A. Application of a single VOC against the *F. verticillioides* on MEA

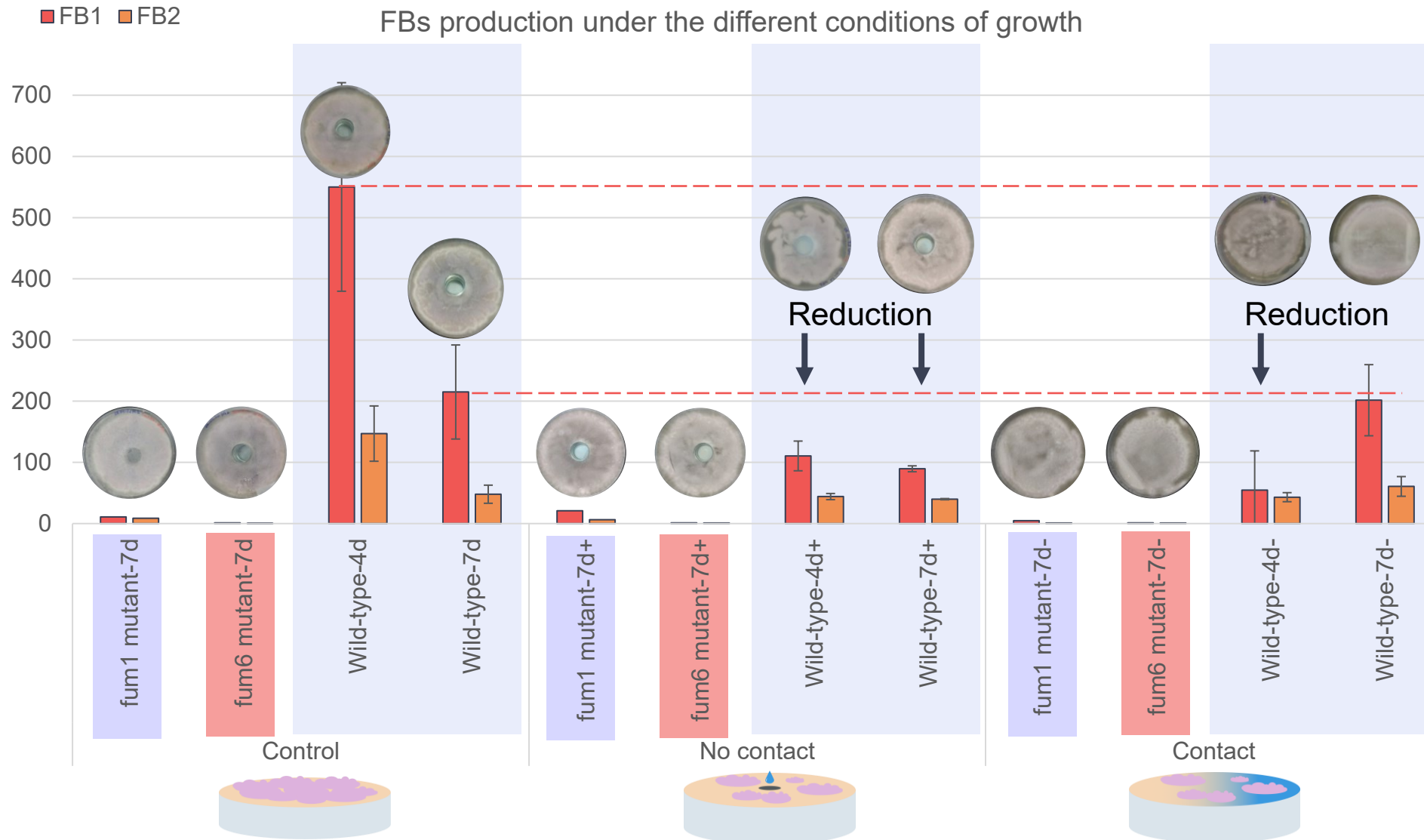


WHAT IF THE SINGLE VOC IS APPLIED IN CONTACT OR NON-CONTACT CONDITION ON THE FUNGI?

→ More effective : Ethyl butanoate and **Ethyl 3-methylbutanoate**



A. Application of a single VOC against the *F. verticillioides* on MEA



NON CONTACT
MORE
PERSISTANT THAN
CONTACT

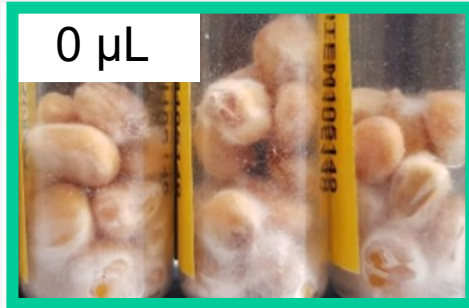


Bioavailability?

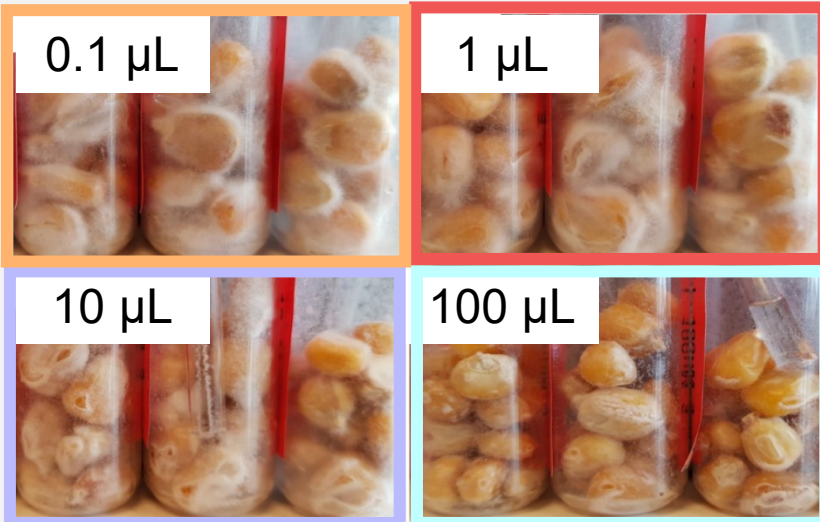
► Mutants ≈ 3ppb

B. Application of a single VOC against the *F. verticillioides* on maize

Visual observation



Fungal development of WT strain at day 6

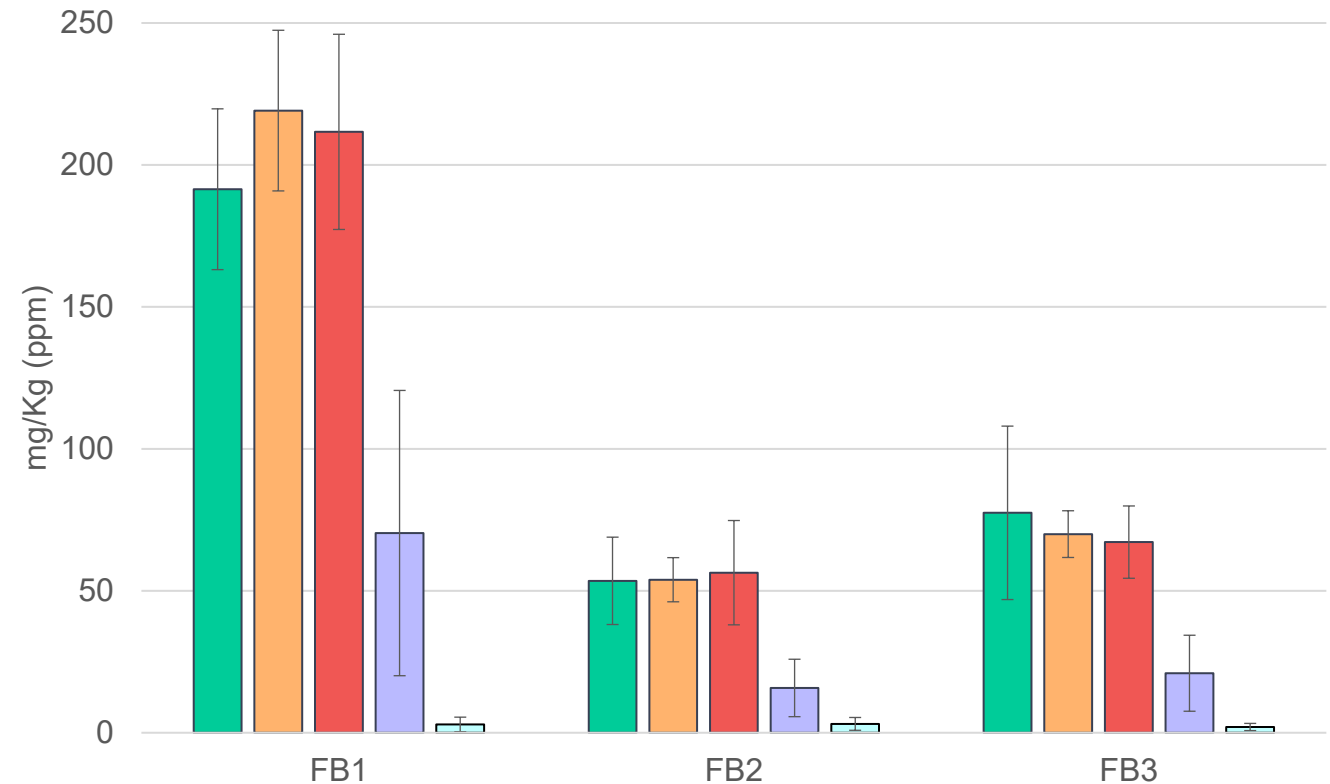


Fungal development of fumonisin-producing strain (WT) in the presence of ethyl 3-methylbutanoate without physical contact

- ▶ Visible growth reduction from 10 μL

Fumonisin production

NON CONTACT

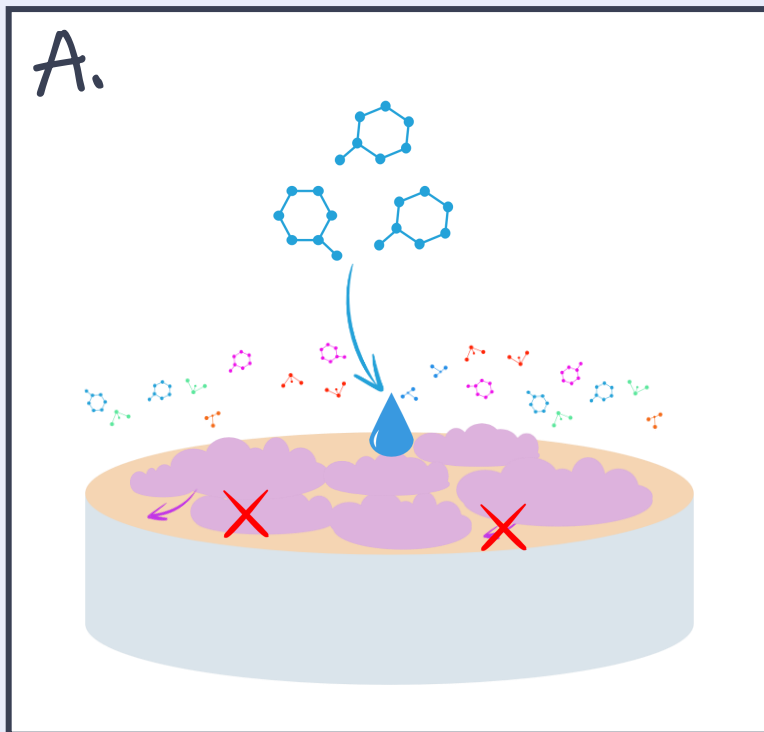


- ▶ Visible reduction of FB production from 10 μL
- ▶ Total inhibition of the FB production from 100 μL (level mutants)

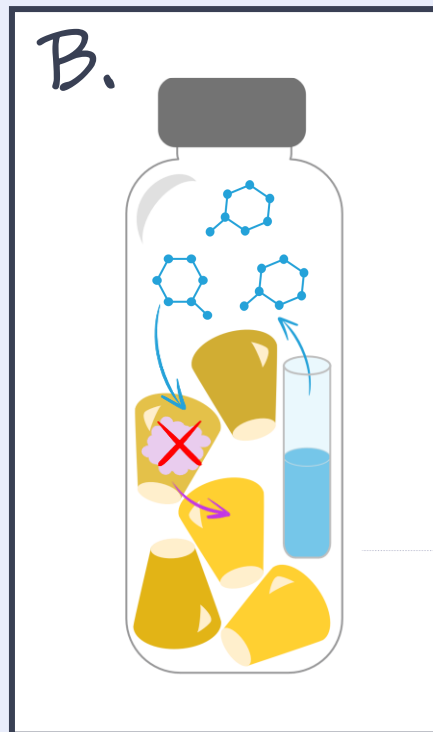
Submitted



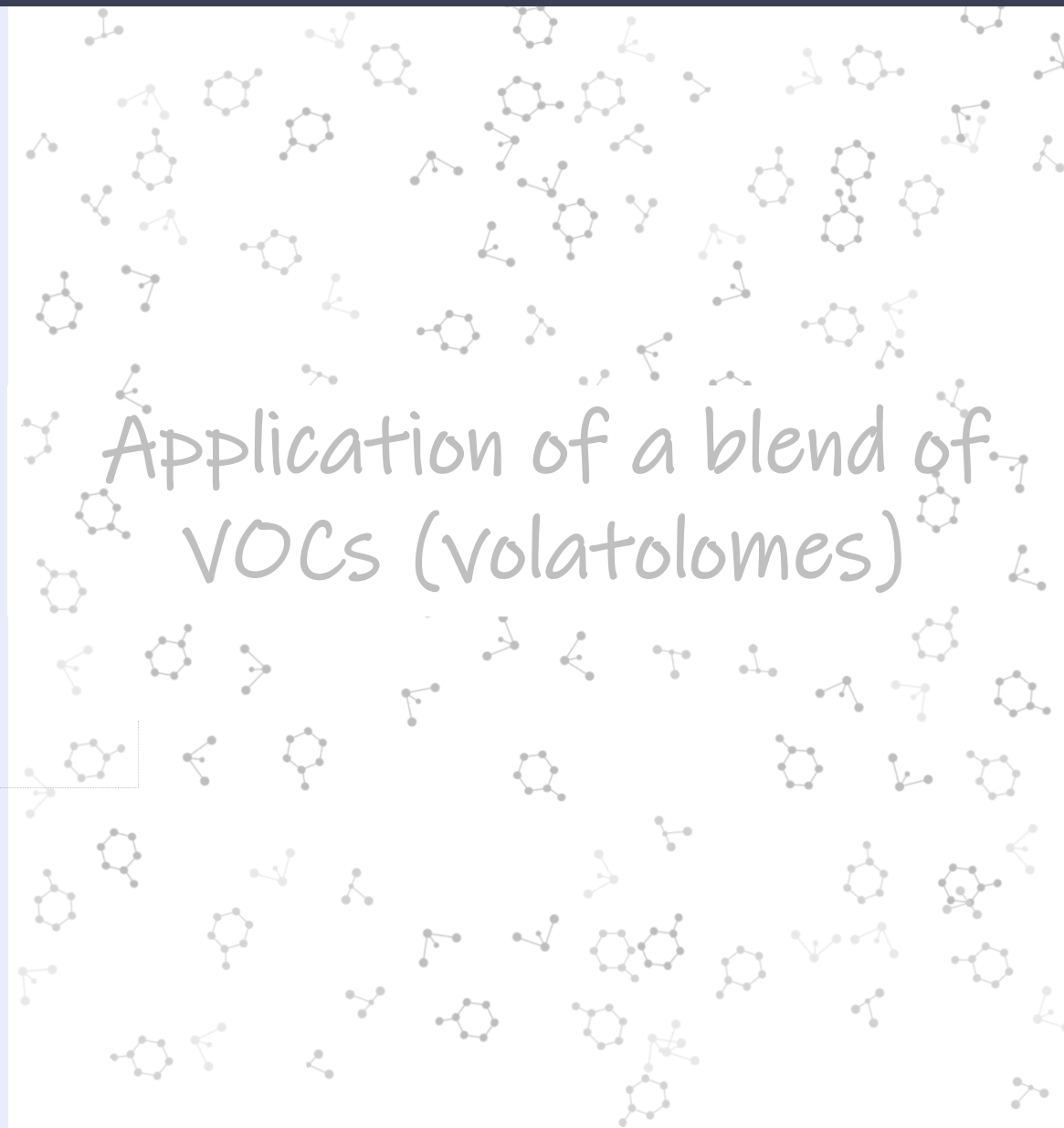
Application of a single VOC



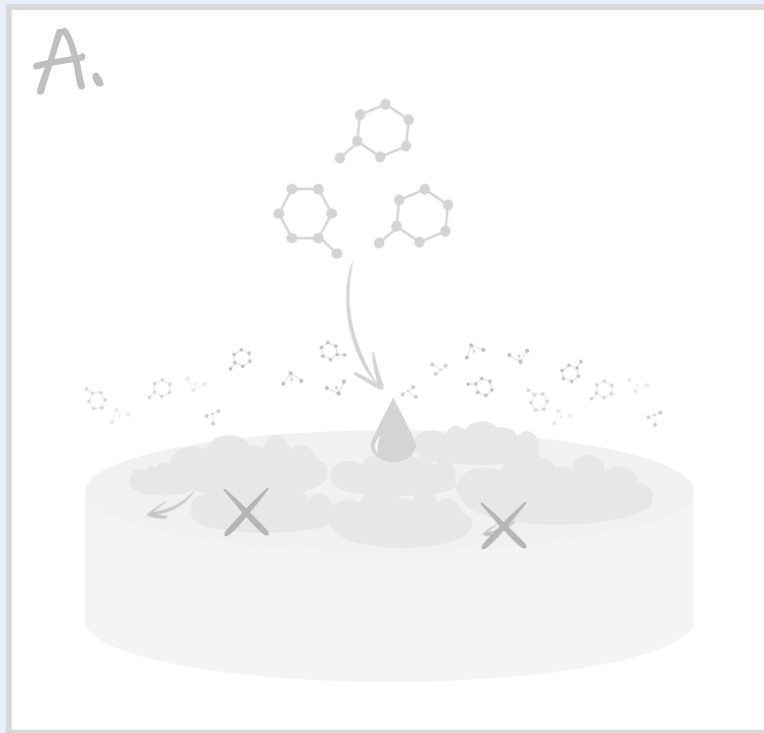
...on MEA



...on maize



Application of a single VOC

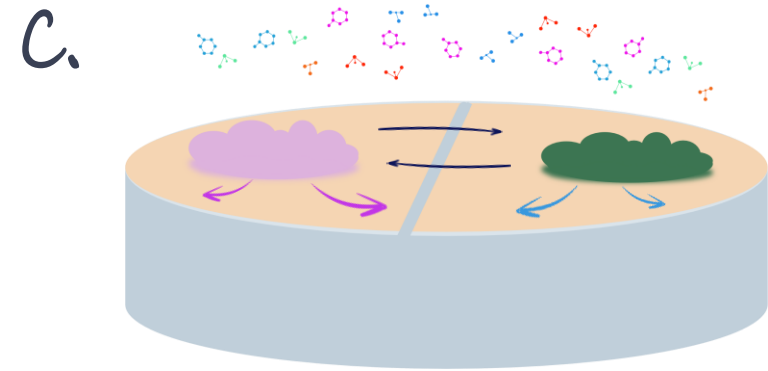


...on MEA

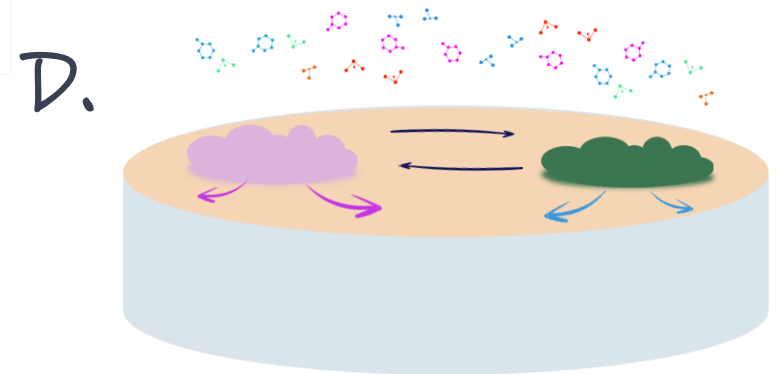


...on maize

Application of a blend of VOCs (volatolomes)



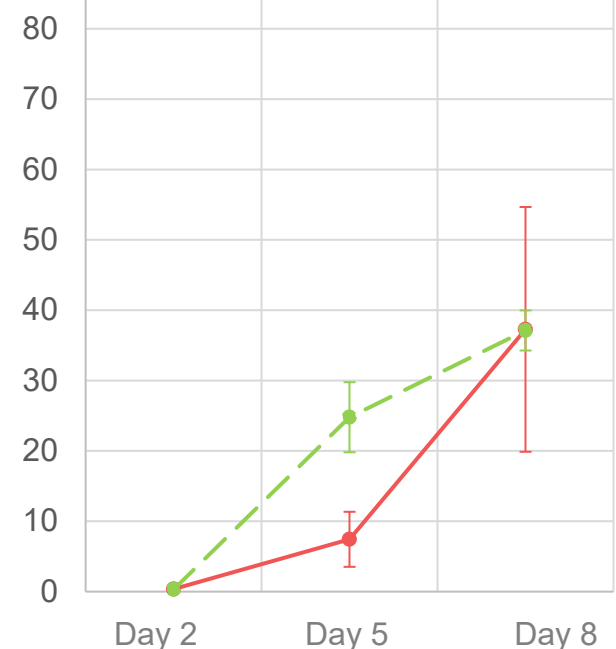
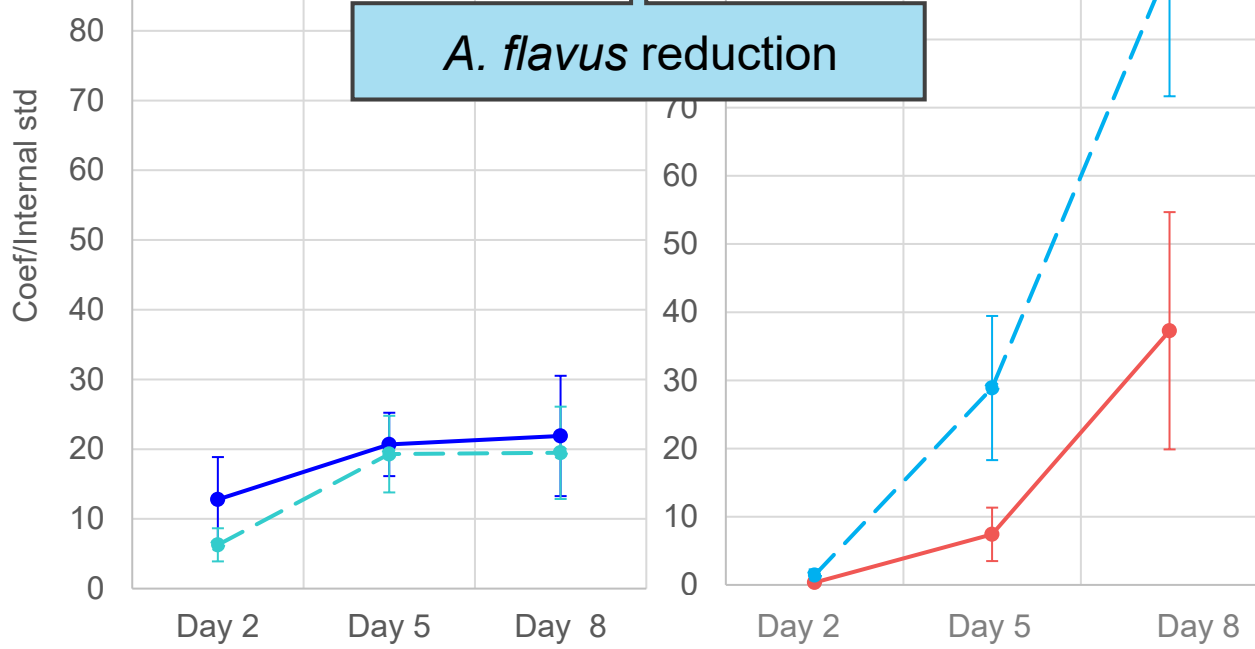
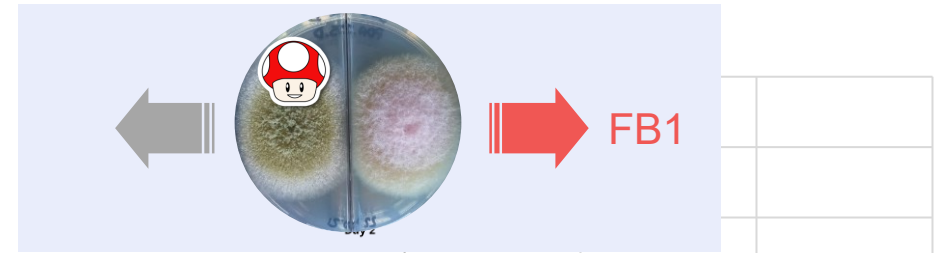
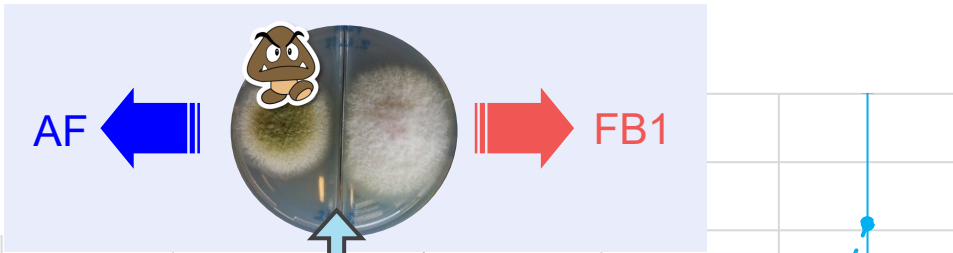
...only sharing the atmosphere



...sharing the media and the atmosphere

C. Mycotoxins produced by *A. flavus* and *F. verticillioides* in the non contact condition

- AfT alone
- Fv alone
- AfT/Fv **No contact**
- AfTN/Fv **No contact**



AFB1

- ▶ AFB1 alone \approx AFB1
- ▶ Visual reduction of AfT

FB1

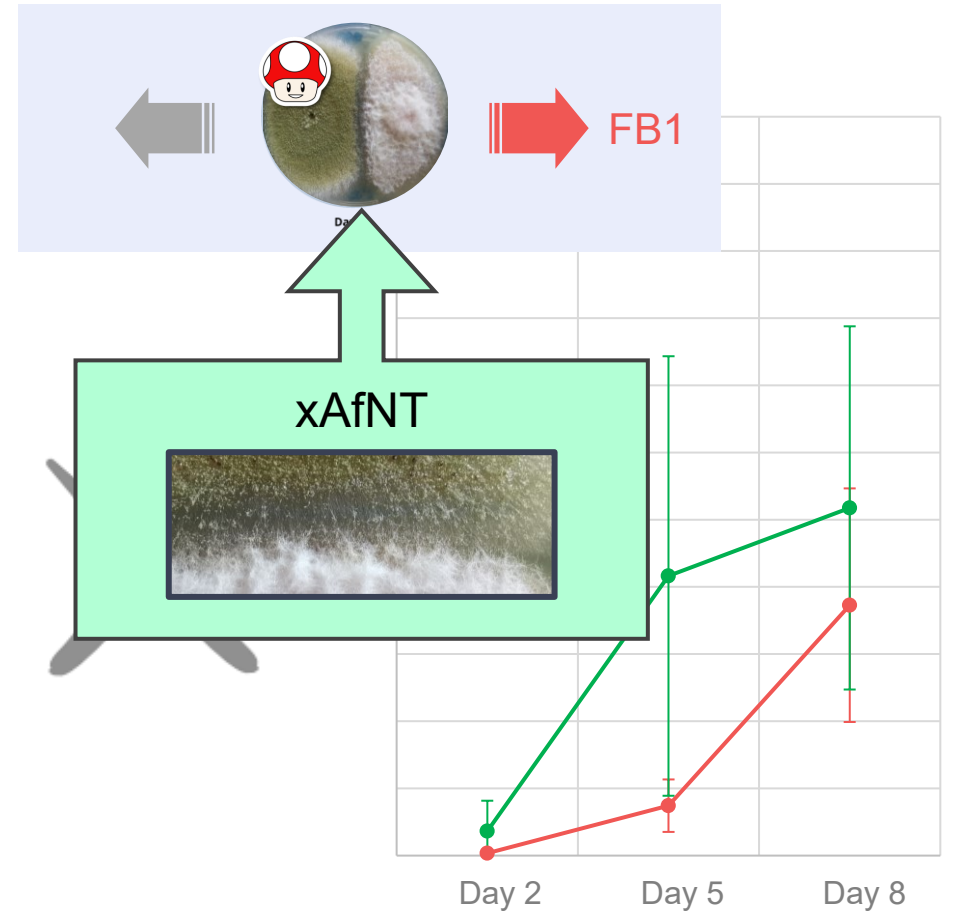
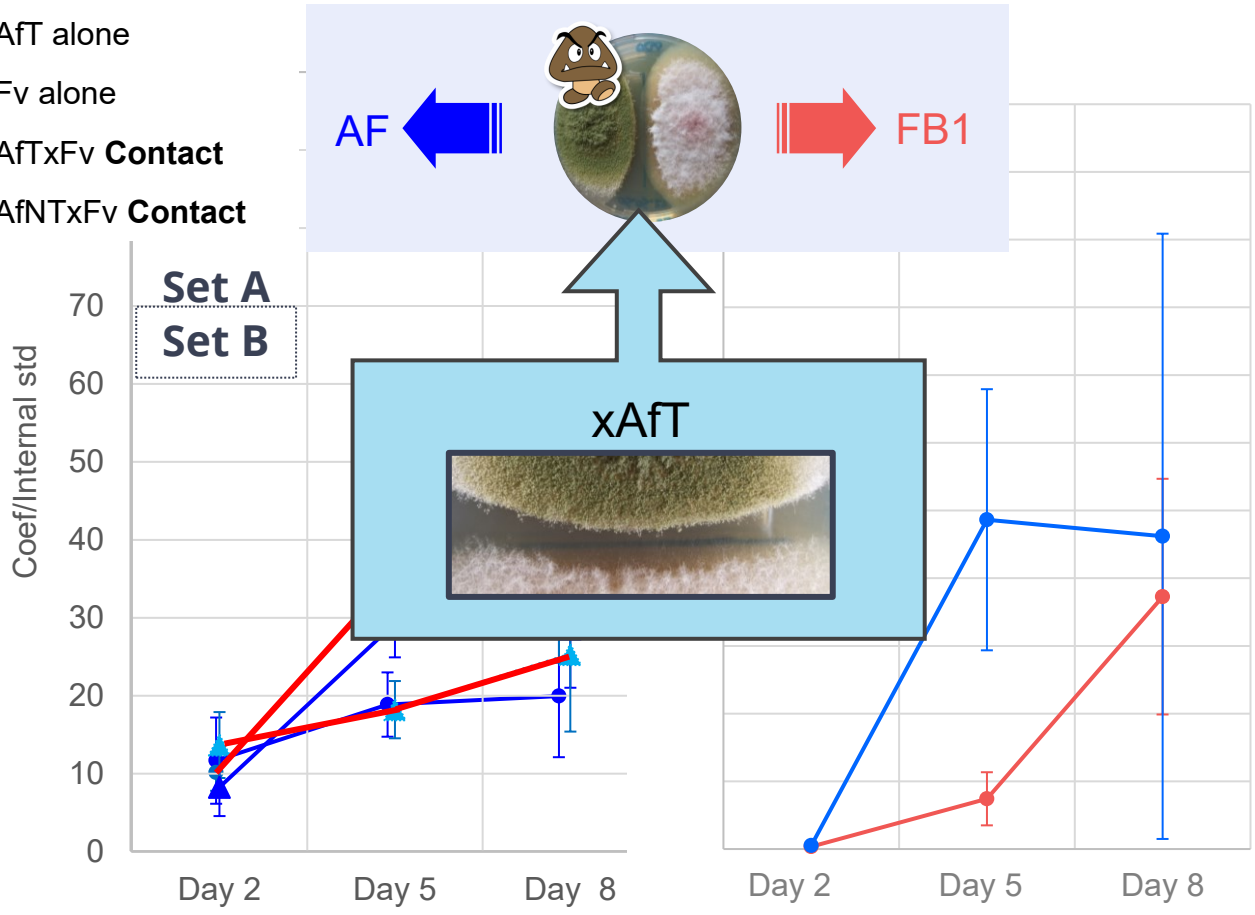
- ▶ Increase of FBs production in pce of Af
- ▶ FB1 AfT/Fv > FB1 AfNT/Fv

Submitted

C. Mycotoxins produced by *A. flavus* and *F. verticillioides* in the contact condition

- AfT alone
- Fv alone
- AfTxFv **Contact**
- AfNTxFv **Contact**

Set A
Set B



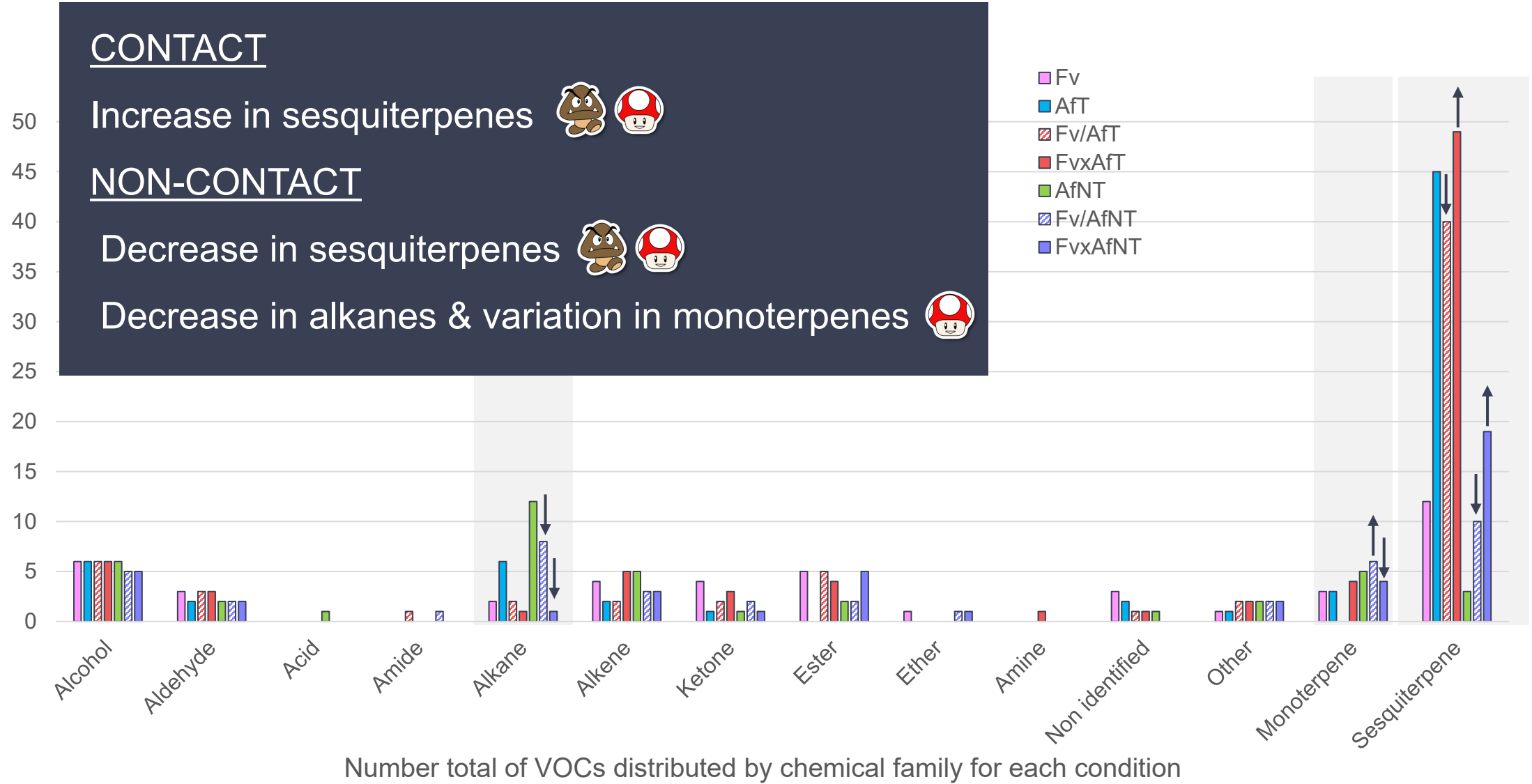
AFB1

▶ AFB1 Contact ≠
▶ ≠ VOCs at day 5 ?

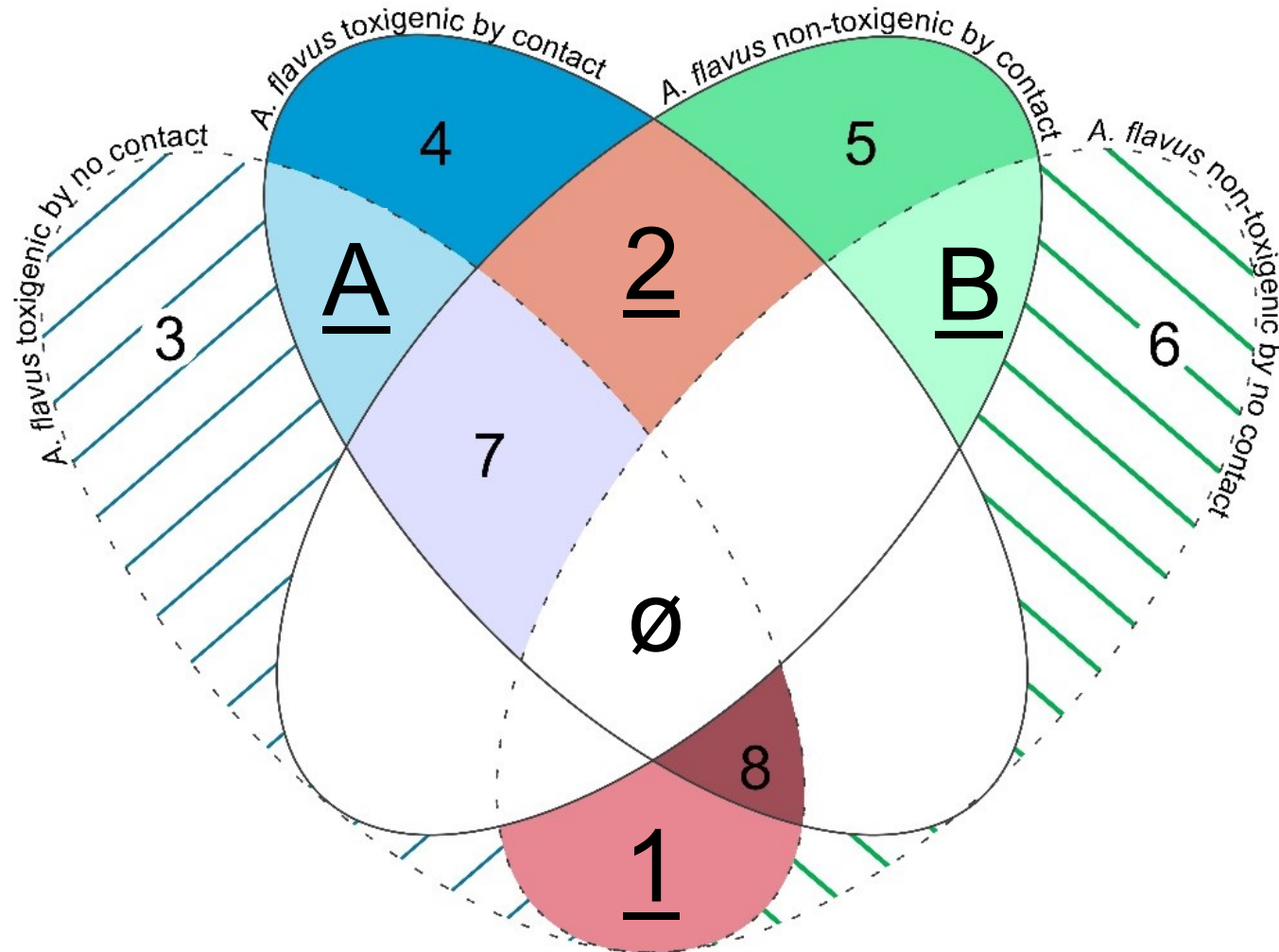
FB1

▶ Increase of FBs production in pce of Af

Submitted



(AfT) *A. flavus toxigenic*, (AfNT) *A. flavus non-toxigenic*, (Fv) *F. verticillioides*, (vs) interaction; Chemical family: (1) Alcohol, (2) Aldehyde, (3) Acid, (4) Amide, (5) Alkane, (6) Alkene, (7) Ketone, (8) Ester, (9) Ether, (10) Amine, (11) Non identified, (12) Other, (13) Monoterpene, (14) Sesquiterpene



SPECIFIC TO AN *A. FLAVUS* STRAIN

A Benzenemethanol 

B Aristolochene 

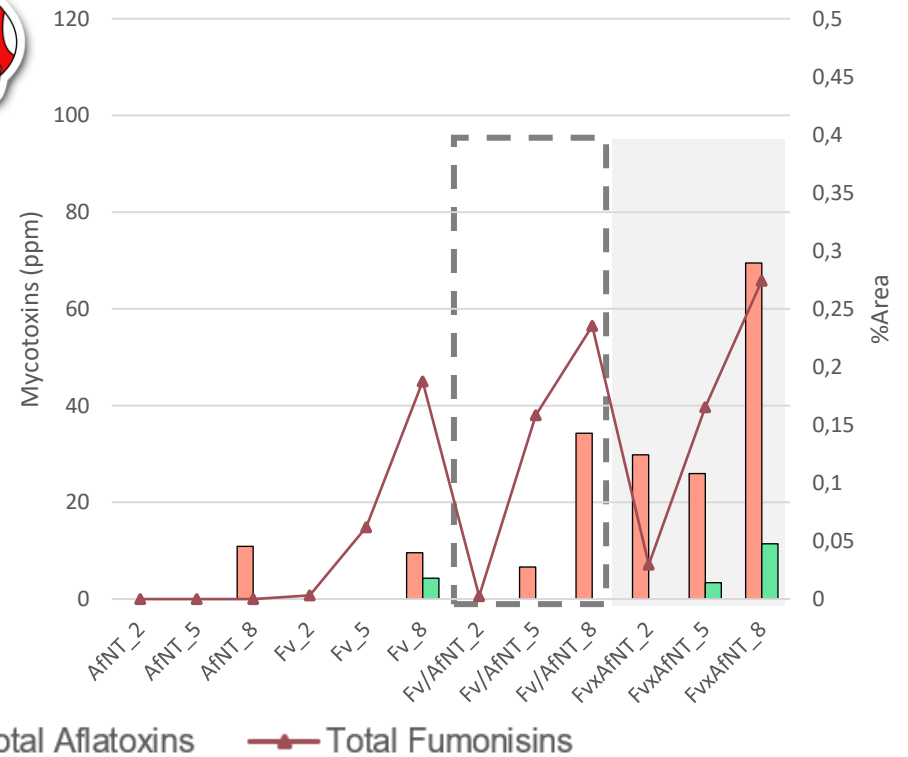
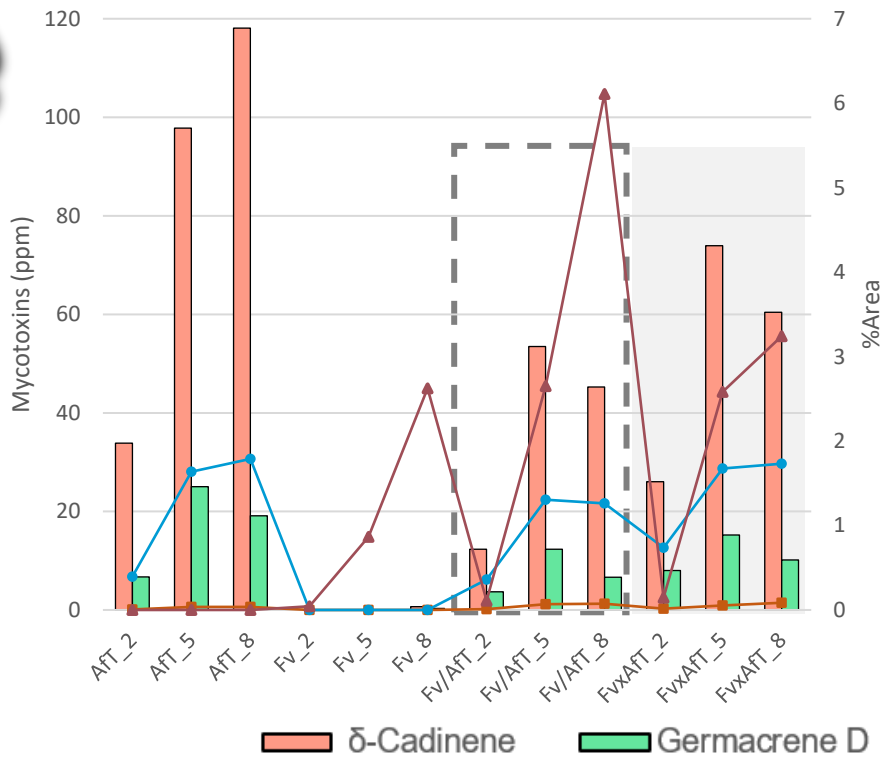
SPECIFIC TO AN INTERACTION

1 4-Ethylbenzamide (Non-contact)

2 Junipene
α-Neoclovene (Contact)

Venn of the VOCs that specifically appeared as in function of the type of interaction (contact and non-contact) and/or the type of *A. flavus* strains (toxigenic or non-toxicogenic) in the presence of *F. verticillioides*

C & D. Correlation between VOCs and Mycotoxins



Average of the total aflatoxins and total fumonisins related to the average of the amount of δ -Cadinene and Germacrene D over the time and in function of the growth conditions (A) for the strains involving the *A. flavus* toxigenic (AFT) and *F. verticillioides* (Fv); (B) for the strains involving the *A. flavus* non-toxicogenic (AfNT) and *F. verticillioides* (Fv) at day 2, 5 and 8.

- ▶ AFs total follow Germacrene D and δ -Cadinene emission tendency
- ▶ δ -Cadinene from day 8 + Germacrene D for Fv
- ▶ FBs follow δ -Cadinene interaction non-contact
- ▶ δ -Cadinene & Germacrene D in contact

→ Combination of Germacrene D and δ -Cadinene related to the toxicity of the strains ?

Fungal volatile organic compounds: new tools to reduce mycotoxin contamination in crops?



	Application of a single VOC	Application of a volatolome
Growth	↙ Reduction	<i>A. flavus</i> reduce in non-contact with Fv
Mycotoxin	Reduction ↘	↖ Augmentation
?	<p>Reduction of mycotoxin related to the growth reduction ?</p> <p>Action on the fumonisin pathway ?</p> <p>Permanent or punctual effect ?</p>	<p>VOC-specific for the different condition: What are their roles?</p>

Depends!

Thank you for your attention.



Keep the VOCs in mind!

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SCAN ME



SCAN ME

