



BEYOND THE SMELL

Evaluation of wireworm potato varietal preference associated with tuber volatile emissions, palatability, and larval fitness

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INTERNATIONAL SYMPOSIUM
ON CROP PROTECTION

ANDREA CHACON HURTADO,
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FRANÇOIS J. VERHEGGEN

Wireworms

Coleoptera: Elateridae





Larvae



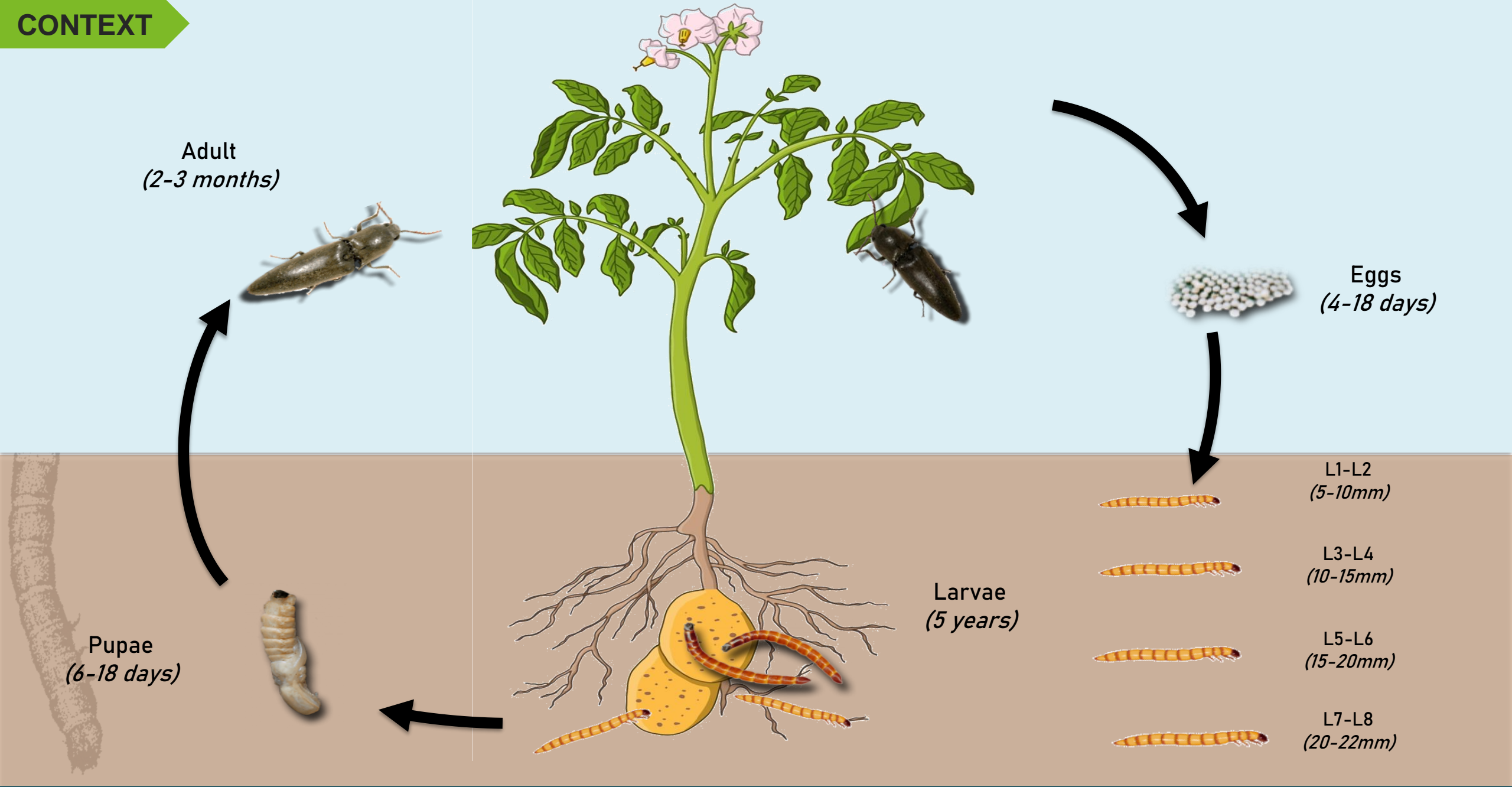
Adult



Chemical

- Organophosphates
- Pyrethroids 
- Neonicotinoids 
(Acetamiprid, Thiacloprid et Thiametoxam)

CONTEXT





1

The role of olfaction in wireworms: a review on their foraging behavior and sensory apparatus

Fanny Barsics, Éric Haubruge, Frédéric Francis, François J. Verheggen

After approaching the CO2 emitter, wireworms uses volatile organic compounds released by the plant in the rhizosphere to select a specific host.

Journal of Pest Science
<https://doi.org/10.1007/s10340-019-01190-w>

ORIGINAL PAPER

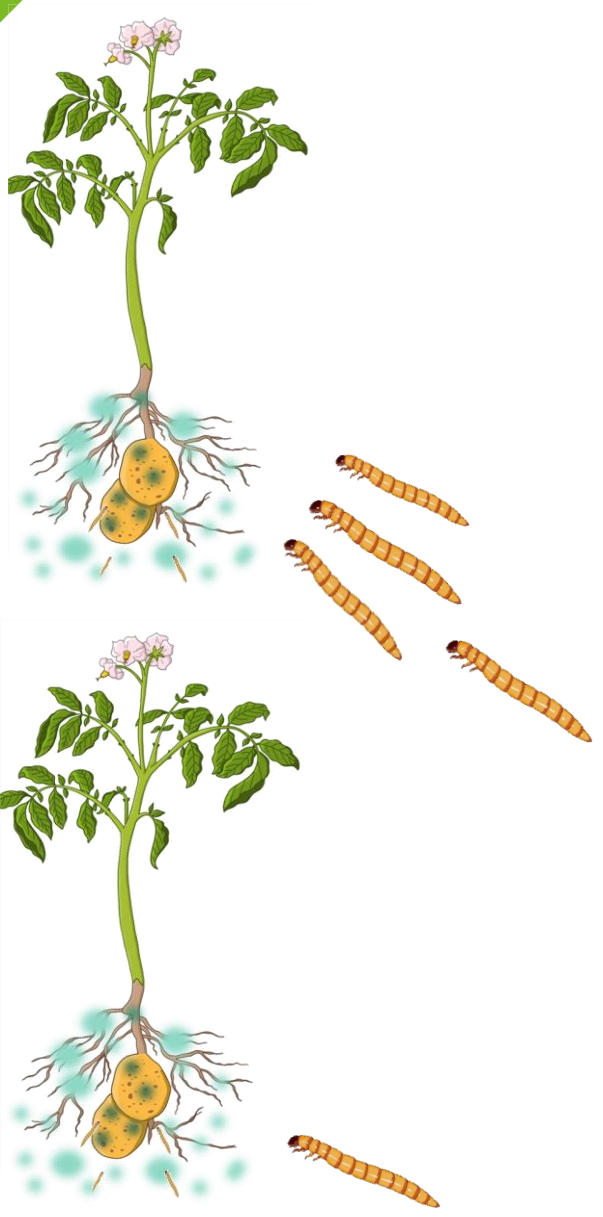


2

Linking variety-dependent root volatile organic compounds in maize with differential infestation by wireworms

Diana la Forgia¹ · Jean-Baptiste Thibord² · Philippe Larroude² · Frédéric Francis¹ · Georges Lognay¹ · François Verheggen¹

Foraging behaviour of wireworms is influenced by belowground volatile organic compounds (VOCs).



Evaluate the level damage on potato variety under laboratory conditions.

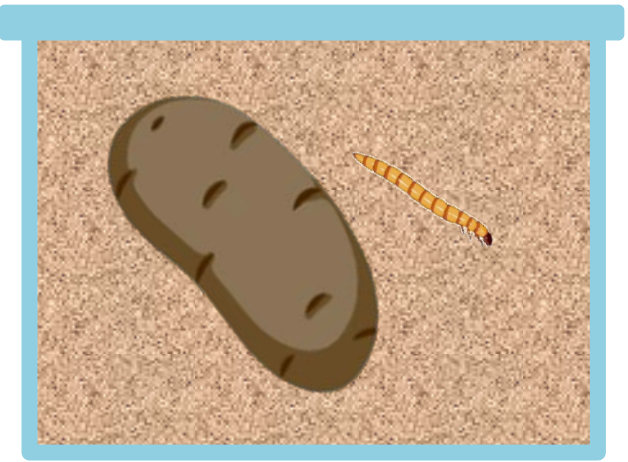
Palatability and the effect on life history traits

Assessing the **attractiveness** of **potato varieties** under controlled conditions

Identify the **semiochemical** that could **drive** the **attraction**



1



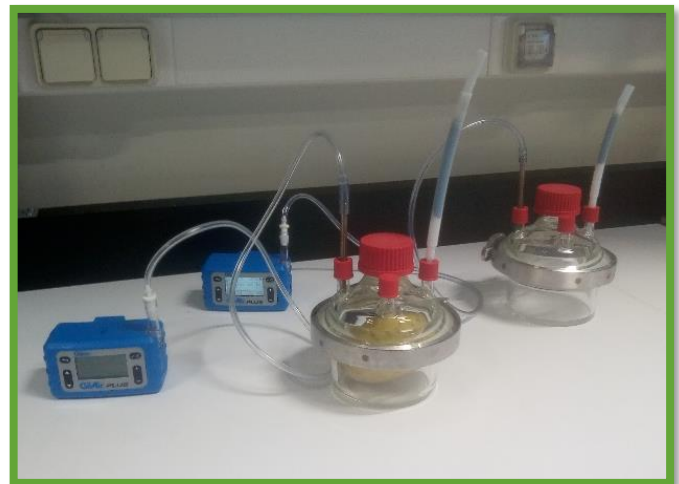
No choice bioassays

2



Dual choice bioassays

3



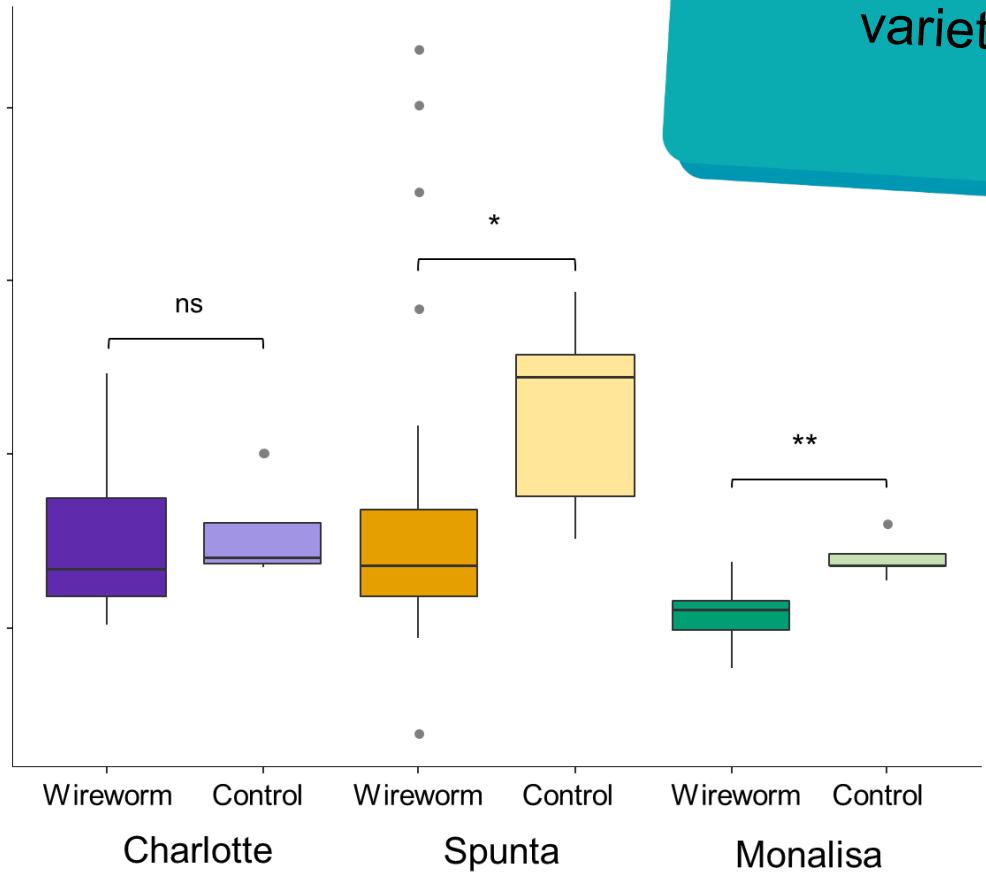
Semiochemical sampling
BBCH 407 and BBCH 409





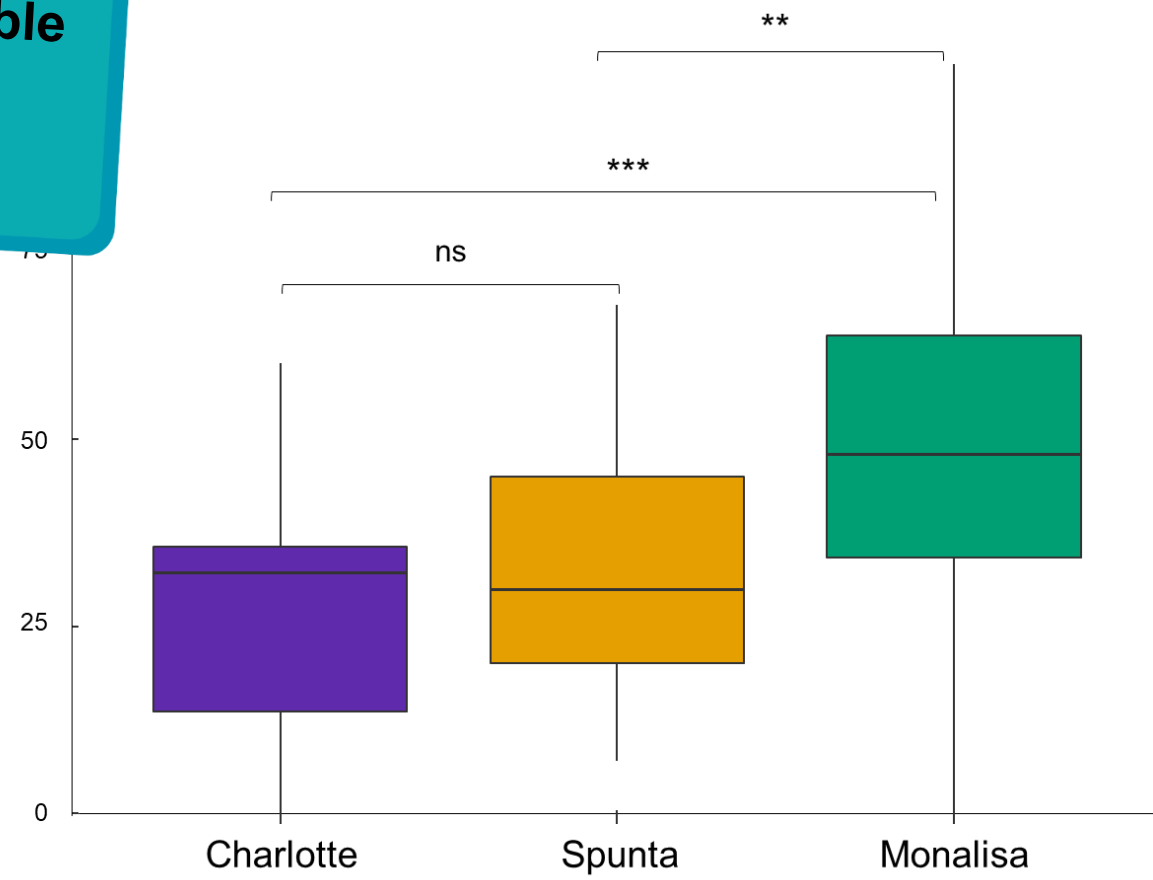
Monalisa is the most susceptible variety

Potato weight variation (gr)

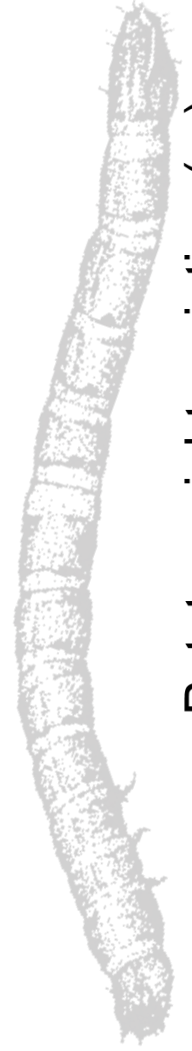


Mann-Whitney-Wilcoxon test

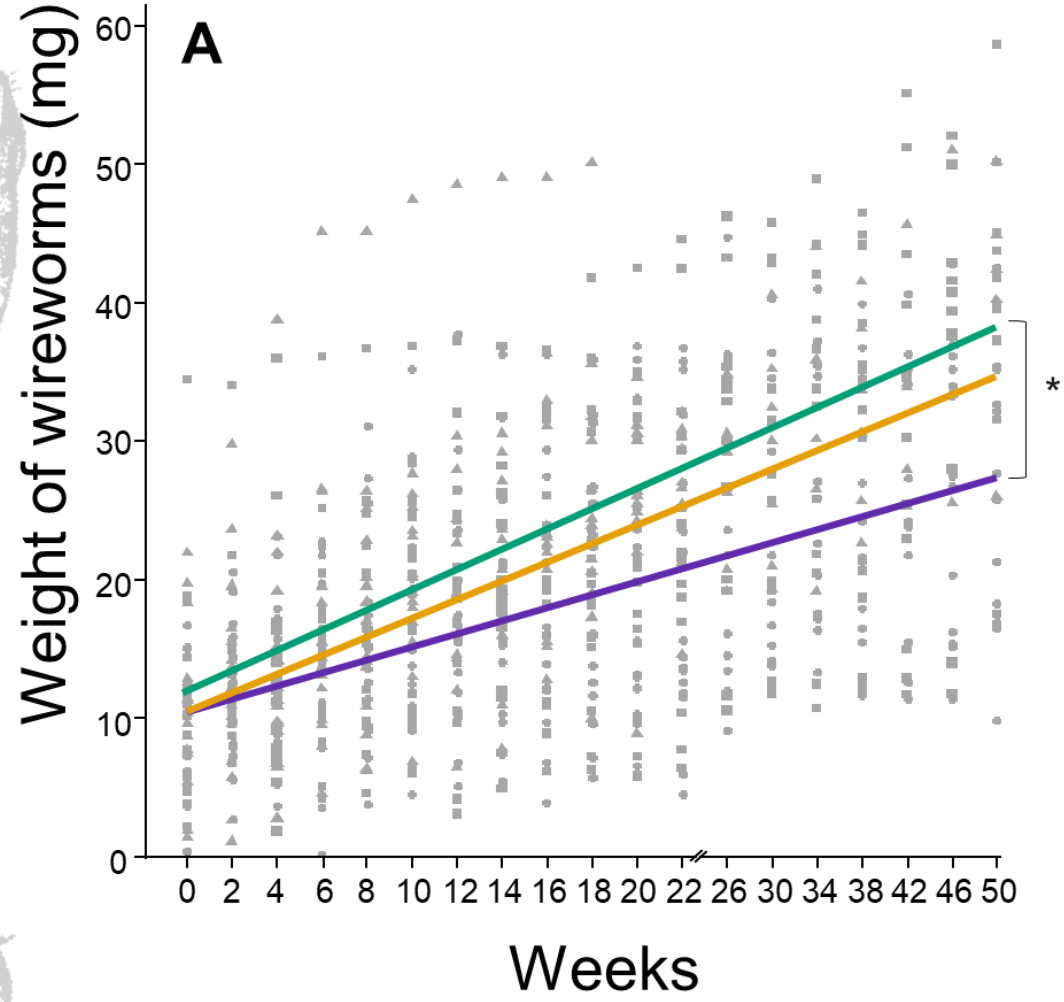
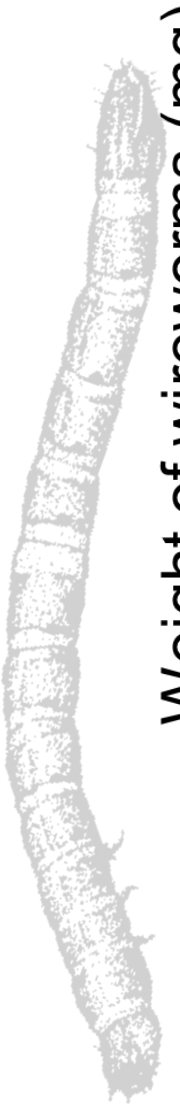
Size of galleries (m)



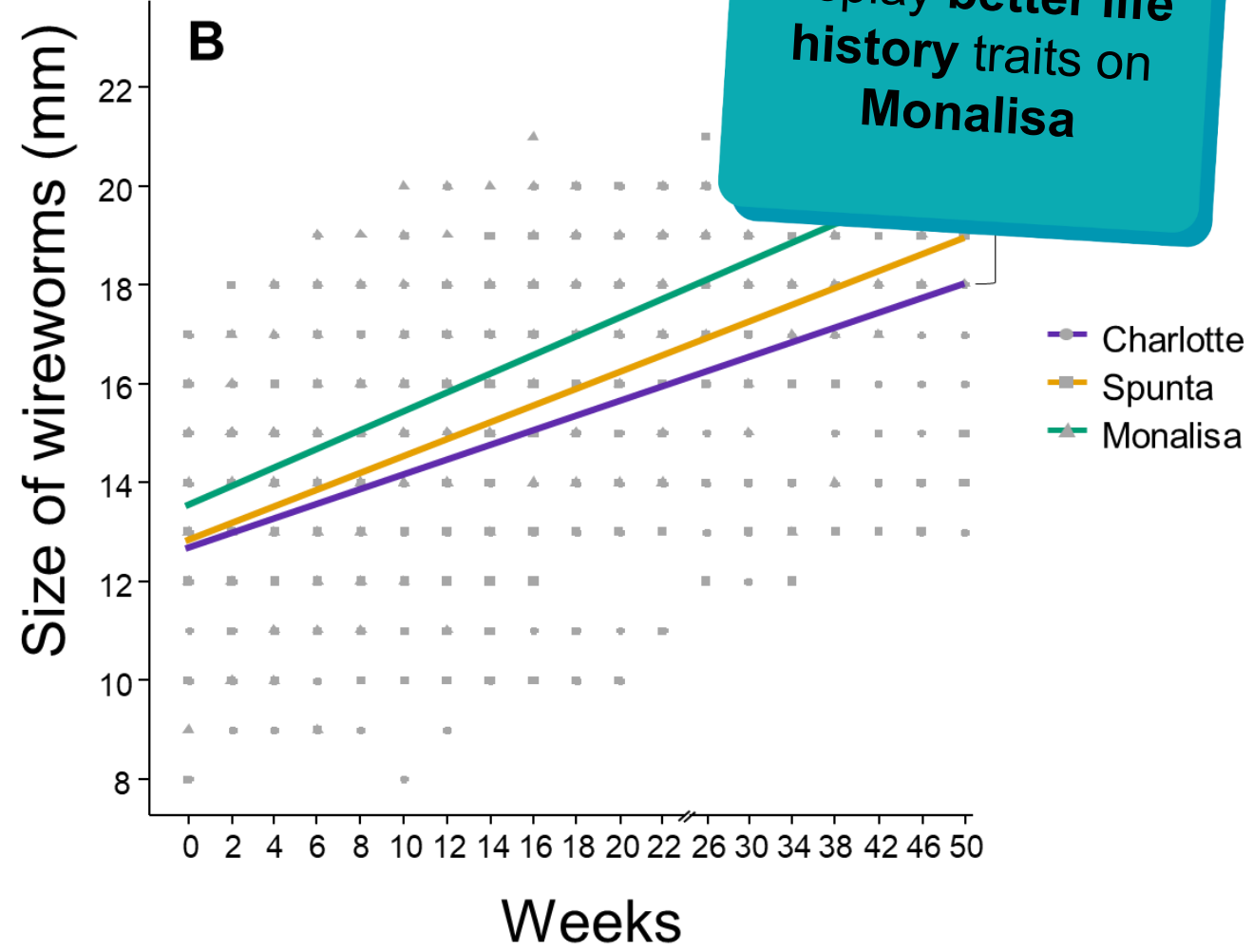
Tukey's HSD test



RESULTS



General linear mixed effects models test

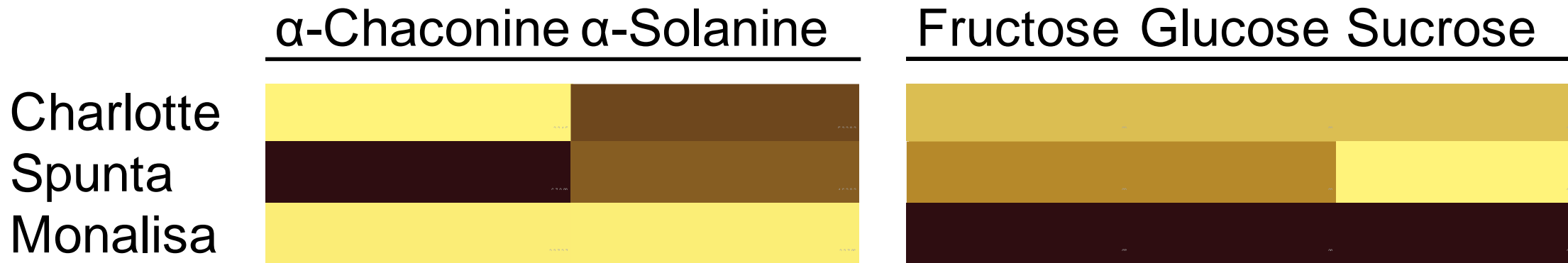


Wireworms display better life history traits on Monalisa



Monalisa presented **lower glycoalkaloid** content and **higher sugar** content.

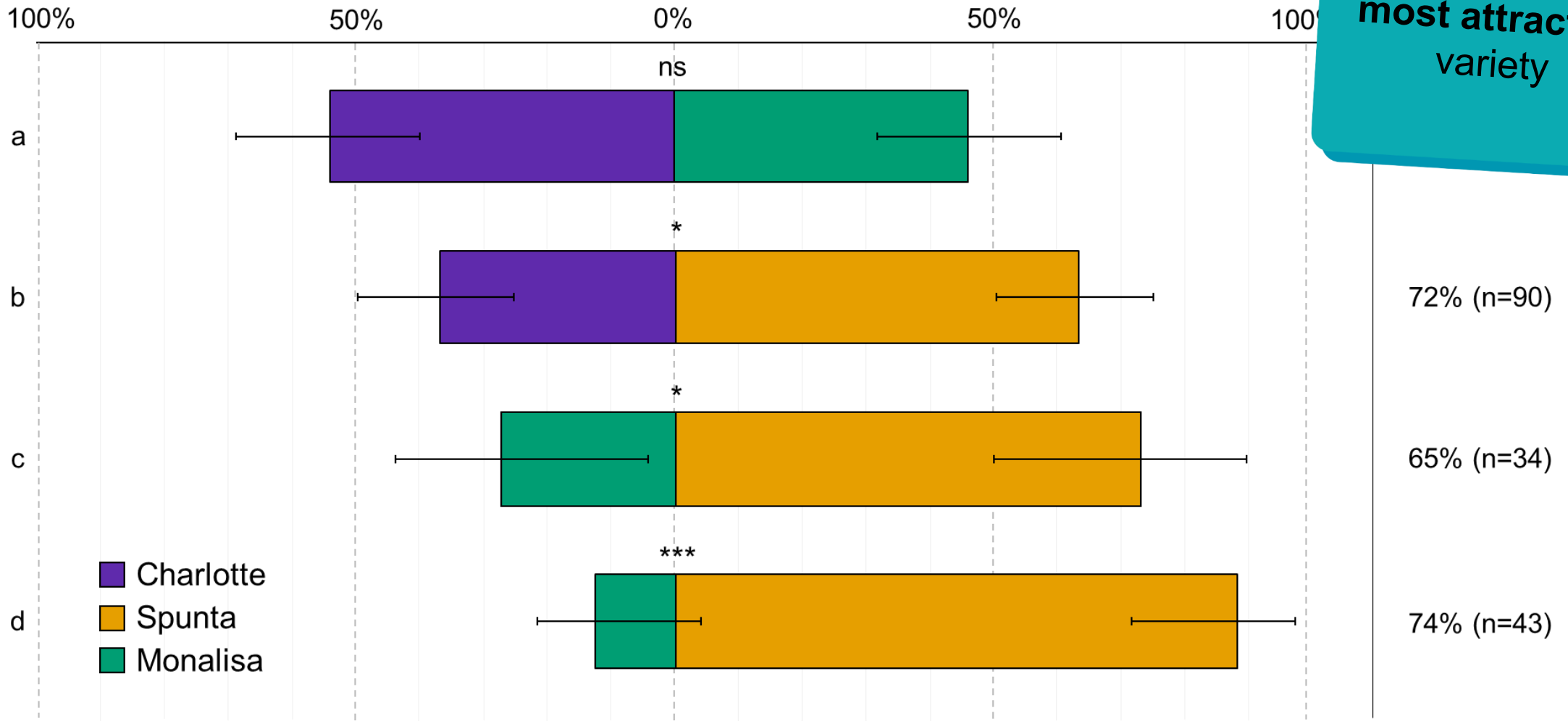
Glycoalkaloid ($\mu\text{g}/\text{kg}$) and sugar content ($\text{g}/100\text{g}$) of potato varieties



RESULTS



Spunta is the most attractive variety



■ Charlotte
■ Spunta
■ Monalisa

Chi-square test



0,02 ng/g

37,20 ng/g

65 VOCs identified
 most representative
Nonanal
1-octen-3-ol
2-phenoxyethanol

Quantity emitted (ng/g of dry peel) (Mean ± S.E.)

Compounds

Aldehydes

- 3-Methylbutanal
- Heptanal
- (E)-2-Heptenal
- Benzaldehyde
- Octanal
- Benzeneacetaldehyde
- (E)-2-Octenal
- (E)-4-Nonenal
- Nonanal
- (E)-2-Nonenal
- (E,E)-2,4-Nonadienal
- (E)-2-Decenal

Alcohols

- 3-Methyl-1-butanol
- Propylene glycol
- 2,3-Butanediol
- 1-Hexanol
- 2-Butoxyethanol
- Hexylene glycol
- 1-Heptanol
- 1-Octen-3-ol
- 2-Ethyl-1-hexanol
- Benzyl alcohol
- 1-Octanol
- 2-Phenyl-2-propanol
- Phenylethyl alcohol
- 1-Nonanol
- 2-Propyl-1-heptanol
- 2-Phenoxyethanol
- 1-Decanol

Compounds	Quantity emitted (ng/g of dry peel) (Mean ± S.E.)					
	First physiological stage			Second physiological stage		
	Charlotte	Spunta	Monalisa	Charlotte	Spunta	Monalisa
3-Methylbutanal	Light	Light	Light	Light	Light	Light
Heptanal	Light	Light	Light	Light	Light	Light
(E)-2-Heptenal	Light	Light	Light	Light	Light	Light
Benzaldehyde	Light	Light	Light	Light	Light	Light
Octanal	Light	Light	Light	Light	Light	Light
Benzeneacetaldehyde	Light	Light	Light	Light	Light	Light
(E)-2-Octenal	Light	Light	Light	Light	Light	Light
(E)-4-Nonenal	Light	Light	Light	Light	Light	Light
<input checked="" type="checkbox"/> Nonanal	Light	Light	Light	Dark	Dark	Dark
(E)-2-Nonenal	Light	Light	Light	Light	Light	Light
(E,E)-2,4-Nonadienal	Light	Light	Light	Light	Light	Light
(E)-2-Decenal	Light	Light	Light	Light	Light	Light
3-Methyl-1-butanol	Light	Light	Light	Light	Light	Light
Propylene glycol	Light	Light	Light	Light	Light	Light
2,3-Butanediol	Light	Light	Light	Light	Light	Light
1-Hexanol	Light	Light	Light	Light	Light	Light
2-Butoxyethanol	Light	Light	Light	Light	Light	Light
Hexylene glycol	Light	Light	Light	Light	Light	Light
1-Heptanol	Light	Light	Light	Light	Light	Light
<input checked="" type="checkbox"/> 1-Octen-3-ol	Light	Light	Light	Dark	Dark	Dark
2-Ethyl-1-hexanol	Light	Light	Light	Light	Light	Light
Benzyl alcohol	Light	Light	Light	Light	Light	Light
1-Octanol	Light	Light	Light	Light	Light	Light
2-Phenyl-2-propanol	Light	Light	Light	Light	Light	Light
Phenylethyl alcohol	Light	Light	Light	Light	Light	Light
1-Nonanol	Light	Light	Light	Light	Light	Light
2-Propyl-1-heptanol	Light	Light	Light	Light	Light	Light
<input checked="" type="checkbox"/> 2-Phenoxyethanol	Light	Light	Light	Dark	Dark	Dark
1-Decanol	Light	Light	Light	Light	Light	Light

Compounds

Acids and carboxylic acids

- Propanoic acid
- 2-Methylpropanoic acid
- 3-Methylbutanoic acid
- 2-Methylbutanoic acid
- Pentanoic acid

Ketones

- Butyrolactone
- Pentalactone
- 6-Methyl-5-hepten-2-one
- 2-Undecanone
- (E)-Geranylacetone

Alkanes and Alkenes

- Heptadecane
- Nonadecane
- Heneicosane

Sesquiterpenes

- Unidentified Sesquiterper
- Unidentified Sesquiterpene

Aromatics

- Styrene
- Benzothiazole
- Diisopropyl-naphthalene 1
- Diisopropyl-naphthalene 2
- Diisopropyl-naphthalene 3
- Diisopropyl-naphthalene 4
- Diisopropyl-naphthalene 5
- Diisopropyl-naphthalene 6

Amines and Amides

- Pyridine
- N-Butylformamide
- Methenamine

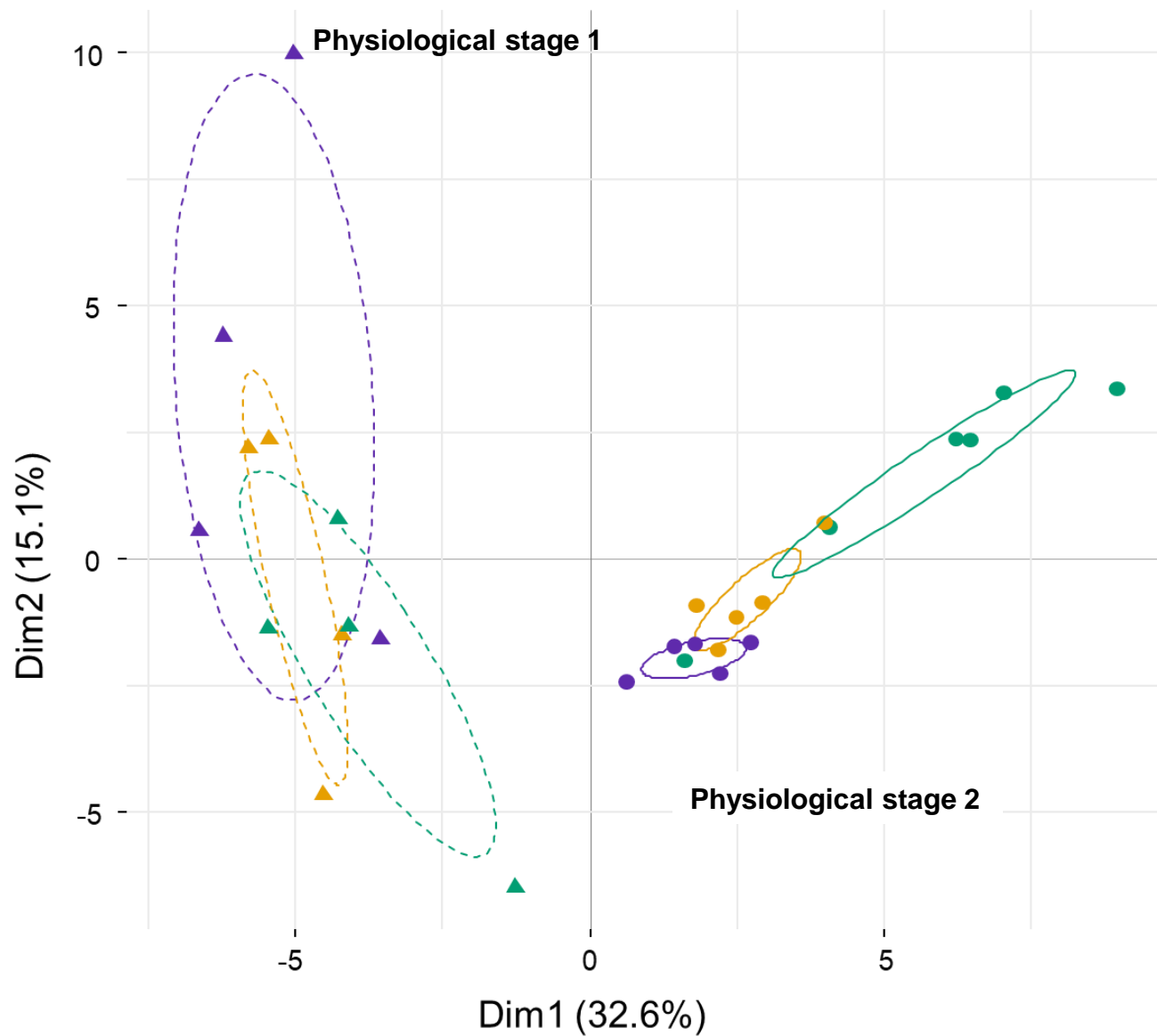
Arenes

- Ethylbenzene

Furans

- 2-Pentylfuran

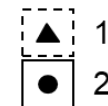
Compounds	Quantity emitted (ng/g of dry peel) (Mean ± S.E.)					
	First physiological stage			Second physiological stage		
	Charlotte	Spunta	Monalisa	Charlotte	Spunta	Monalisa
Propanoic acid	Light	Light	Light	Light	Light	Light
2-Methylpropanoic acid	Light	Light	Light	Light	Light	Light
3-Methylbutanoic acid	Light	Light	Light	Light	Light	Light
2-Methylbutanoic acid	Light	Light	Light	Light	Light	Light
Pentanoic acid	Light	Light	Light	Light	Light	Light
Butyrolactone	Light	Light	Light	Light	Light	Light
Pentalactone	Light	Light	Light	Light	Light	Light
6-Methyl-5-hepten-2-one	Light	Light	Light	Light	Light	Light
2-Undecanone	Light	Light	Light	Light	Light	Light
(E)-Geranylacetone	Light	Light	Light	Light	Light	Light
Heptadecane	Light	Light	Light	Light	Light	Light
Nonadecane	Light	Light	Light	Light	Light	Light
Heneicosane	Light	Light	Light	Light	Light	Light
Unidentified Sesquiterper	Light	Light	Light	Light	Light	Light
Unidentified Sesquiterpene	Light	Light	Light	Light	Light	Light
Styrene	Light	Light	Light	Light	Light	Light
Benzothiazole	Light	Light	Light	Light	Light	Light
Diisopropyl-naphthalene 1	Light	Light	Light	Light	Light	Light
Diisopropyl-naphthalene 2	Light	Light	Light	Light	Light	Light
Diisopropyl-naphthalene 3	Light	Light	Light	Light	Light	Light
Diisopropyl-naphthalene 4	Light	Light	Light	Light	Light	Light
Diisopropyl-naphthalene 5	Light	Light	Light	Light	Light	Light
Diisopropyl-naphthalene 6	Light	Light	Light	Light	Light	Light
Pyridine	Light	Light	Light	Light	Light	Light
N-Butylformamide	Light	Light	Light	Light	Light	Light
Methenamine	Light	Light	Light	Light	Light	Light
Ethylbenzene	Light	Light	Light	Light	Light	Light
2-Pentylfuran	Light	Light	Light	Light	Light	Light



PermManova. Comparison of VOC profiles: physiological stage and variety

Physiological stage 2 displays the most diversified odor profile
(but no difference)

Physiological stage



Variety



Feeding activity is **higher** on **Monalisa tuber**, confirming field observations

Development was significantly better when feeding on the **Monalisa** variety

The **host plant quality** is then assessed by their contents in **primary metabolites** (fatty acids, amino acids, and carbohydrates)

The **volatile** collection analyses could **not** highlight **significant difference** in odor profiles

Nonanal, 1-octen-3-ol, 2-phenoxyethanol, are good candidates to use in **attract-and-kill strategie**



Potato cultivar susceptibility to wireworms: feeding behaviour, fitness and semiochemical-based host selection

Andrea Chacon Hurtado¹, Fanny Ruhland¹, Antoine Boullis¹, François J. Verheggen^{1,*}

¹ Chemical and Behavioral Ecology, Gembloux Agro-Bio Tech, Université de Liège, Avenue de la Faculté d'Agronomie 2B, 5030, Gembloux, Belgium



François Verheggen's Lab





Finding my way : Characterisation of maize roots volatiles that guide wireworms

Fanny Ruhland, Clément Martin & François J. Verheggen

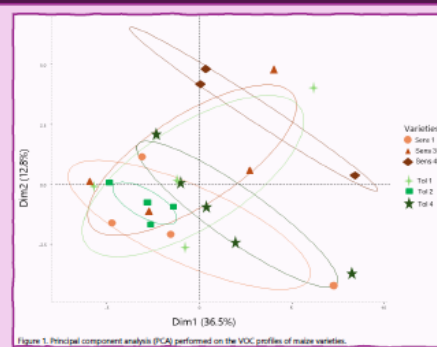
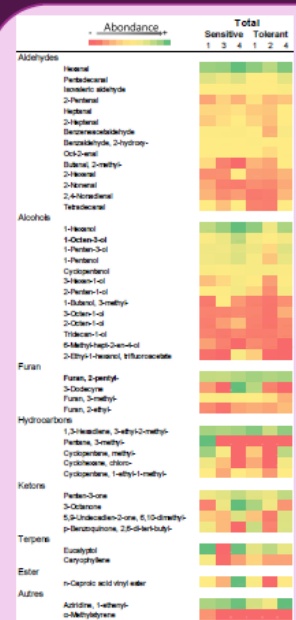
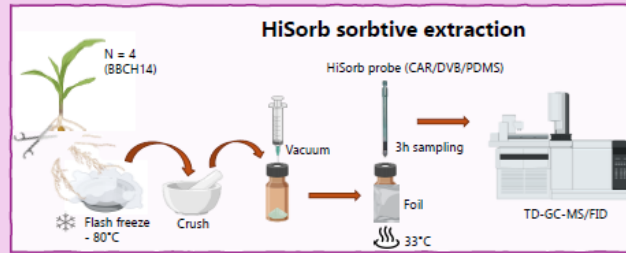
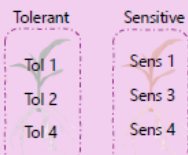
Chemical and Behavioural Ecology, Gembloux Agro-Bio Tech, TERRA, University of Liège, Gembloux, Belgium

Maize roots (*Zea mays* L.) can be damaged by soil-dwelling pests like wireworms (*Agriotes* sp.). These pests rely on chemicals, including volatile organic compounds (VOCs), released by plant roots to find and feed on them. French field surveys have identified contrasted levels of attacks regarding maize varieties.

In this study, we aimed at deciphering the volatile cues released by maize roots and potentially involved in the varietal sensitivity observed on the field.

Methods

6 maize varieties



Profile comparisons (PerMANOVA)
Tolerant VS Sensitive
($F_{1,21} = 1.025$ $p = 0.36$)
between varieties
($F_{1,17} = 1.443$ $p = 0.15$)

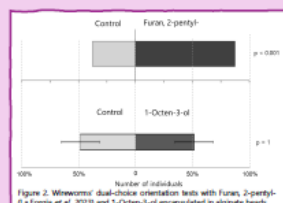


Figure 2. Wireworm dual-choice orientation tests with Furan, 2-pentyl- (E Fargie et al., 2023) and 1-Octen-3-ol encapsulated in alginate beads.

No varietal differences in roots VOCs profiles.
Furan, 2-pentyl- is a good candidate as attractant.
What about seedlings ?

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Poster E-06

