Non-target effects of pesticides on terrestrial ecosystems

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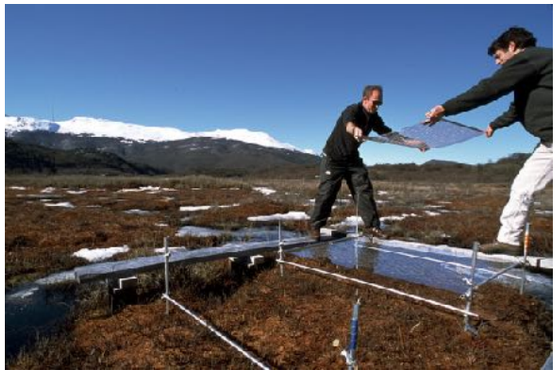
Greens Complementary Hearing on Pesticides - Wed, 05 Sept 2018

EU-Parliament, Brussels

Research topics covered so far

Climate change
- elevated CO_2
- ultraviolet-B radiation
- warming



Agroecology
- weed control (sheeps, mowing)
- tillage (intensive vs. reduced)
- pest-beneficial interactions (landscape structure)

Pesticide effects from an ecological angle
- herbicides (glyphosate, glufosinate, flazasulfuron)
- insecticides (neonics, seed dressings)
- fungicides (seed dressings)
- molluscicides

Our approach

- ☑ as close to real-world situation as possible
- ☑ field soil (not sterilized)
- ☑ using species living in agricultural fields
- ☑ organisms studied so far: earthworms, springtails, microorganisms in soils and on plants, mycorrhizal fungi, protozoa, snails, slugs, plants, algae
- ☑ testing formulations rather than only active ingredients (e.g. Roundup instead of glyphosate)

Herbicide effects on soil biota

Greenhouse & field studies

- field soil containing natural microorganisms
- establishment of weed communities
- multi-species setting, studying ecological interactions
- additional stress factors: competition, temperature etc.

Test guidelines: soil organisms

Earthworm acute toxicity test (OECD test guideline 207): spp. Eisenia fetida; contact test on filter paper or artificial soil, mortality assessed 7 and 14 days after application; test temperature 20°C.

Earthworm reproduction test (OECD TG 222): spp. Eisenia fetida/ Eisenia andrei; mortality and growth effects are determined after 4 weeks, adult worms are then transferred into other soil, offspring counted after another 4 weeks; test temperature 20°C.

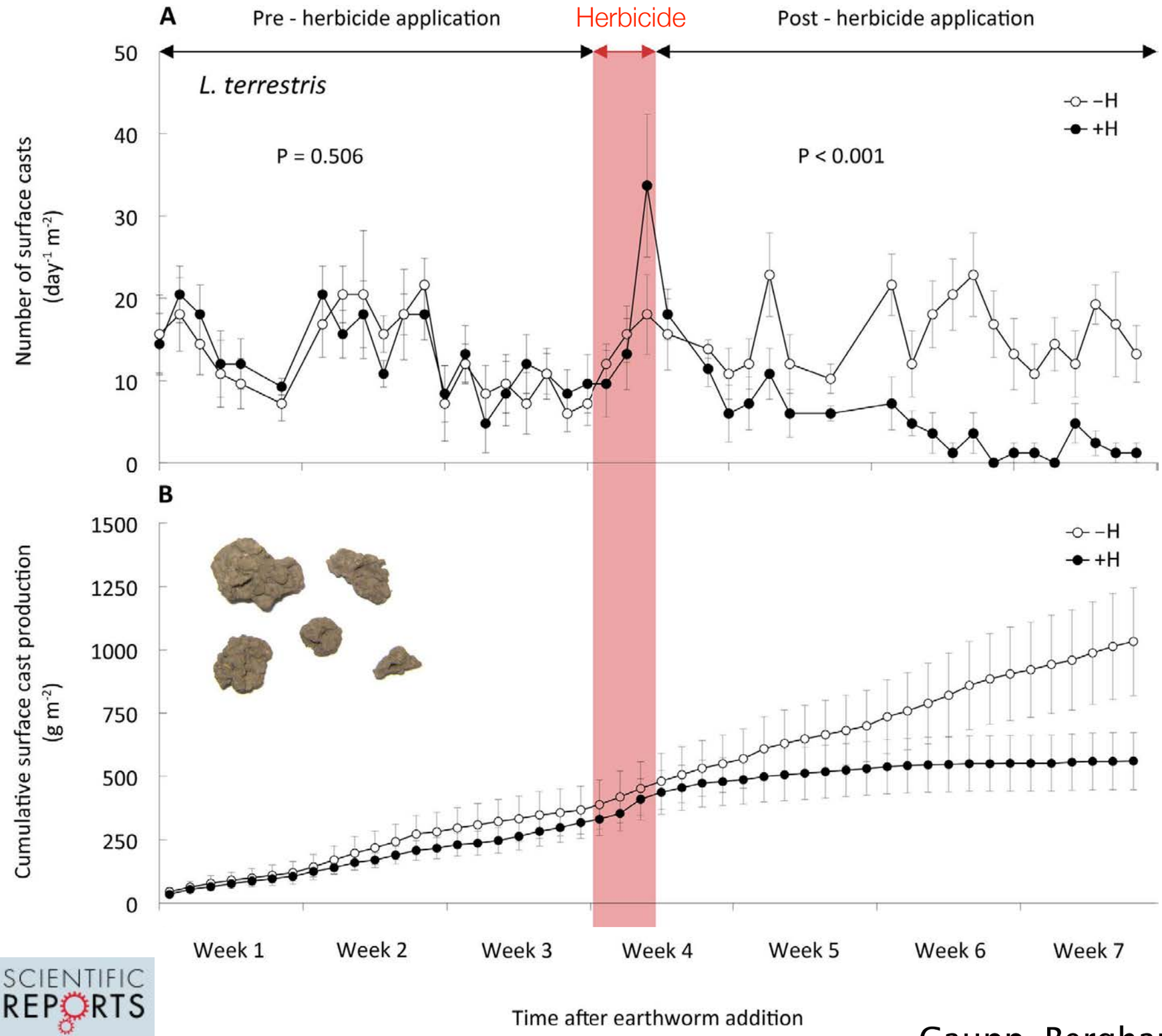
OECD publishing

OECD Guidelines for Testing of Chemicals Section 2: Effects on Biotic Systems

OECD

www.oecd.org

Reduced earthworm activity



without herbicide

-85 %

with herbicide

without herbicide

-46 %

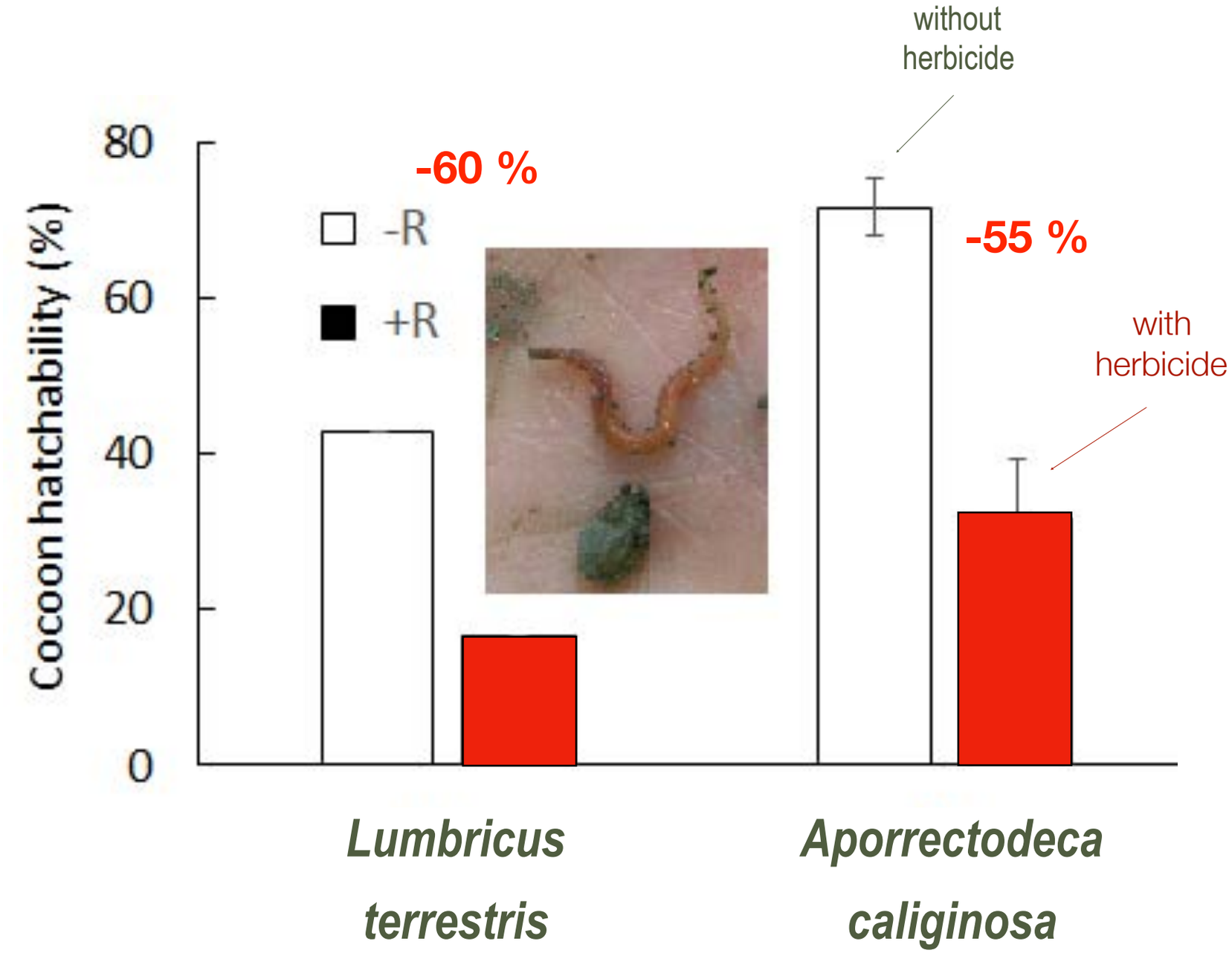
with herbicide

SCIENTIFIC REPORTS

Gaupp-Berghausen et al. 2015, Sci Rep

Reduced earthworm reproduction

15 weeks after herbicide application



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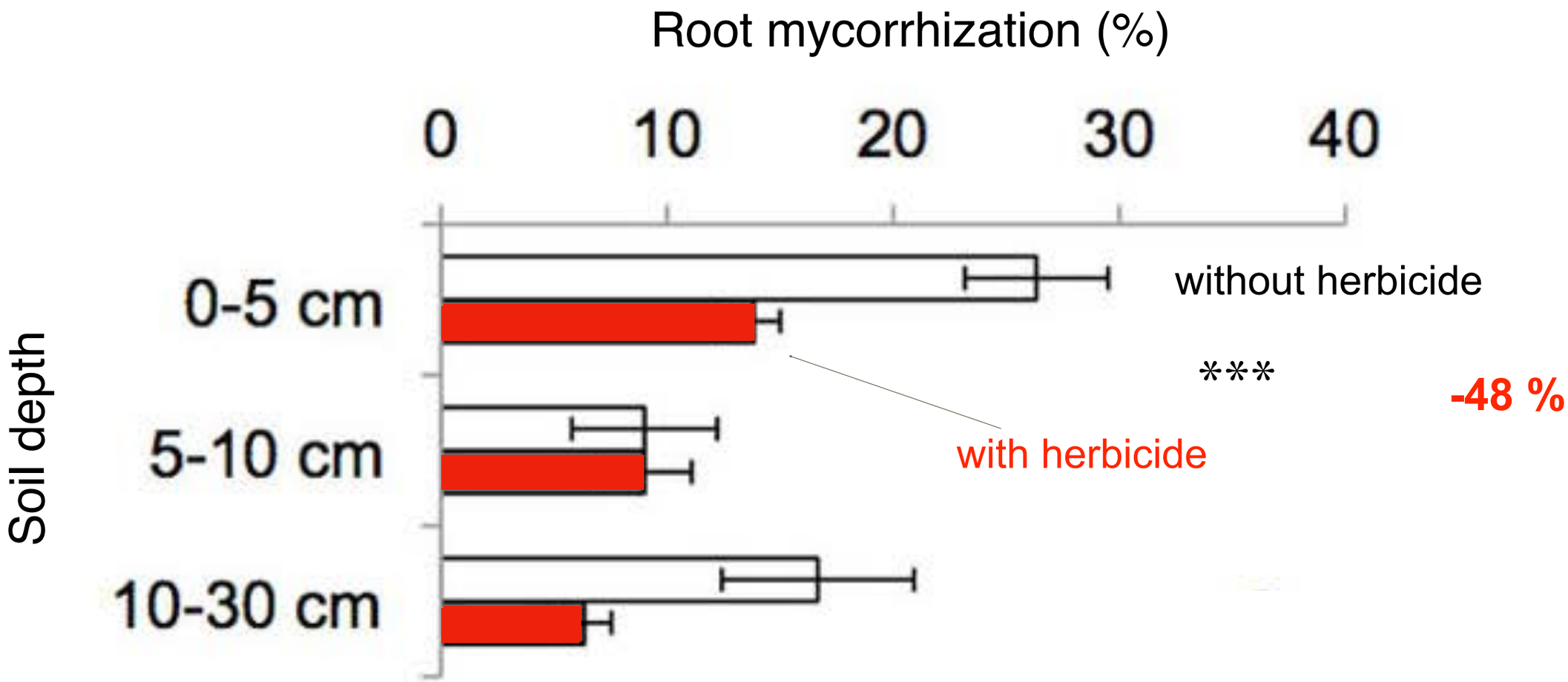
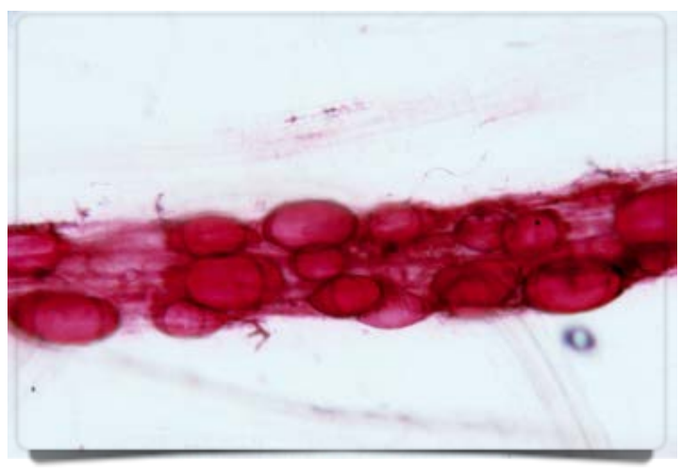
Gaupp-Berghausen et al. 2015, Sci Rep

Herbicides reduce mycorrhizae

pot experiment



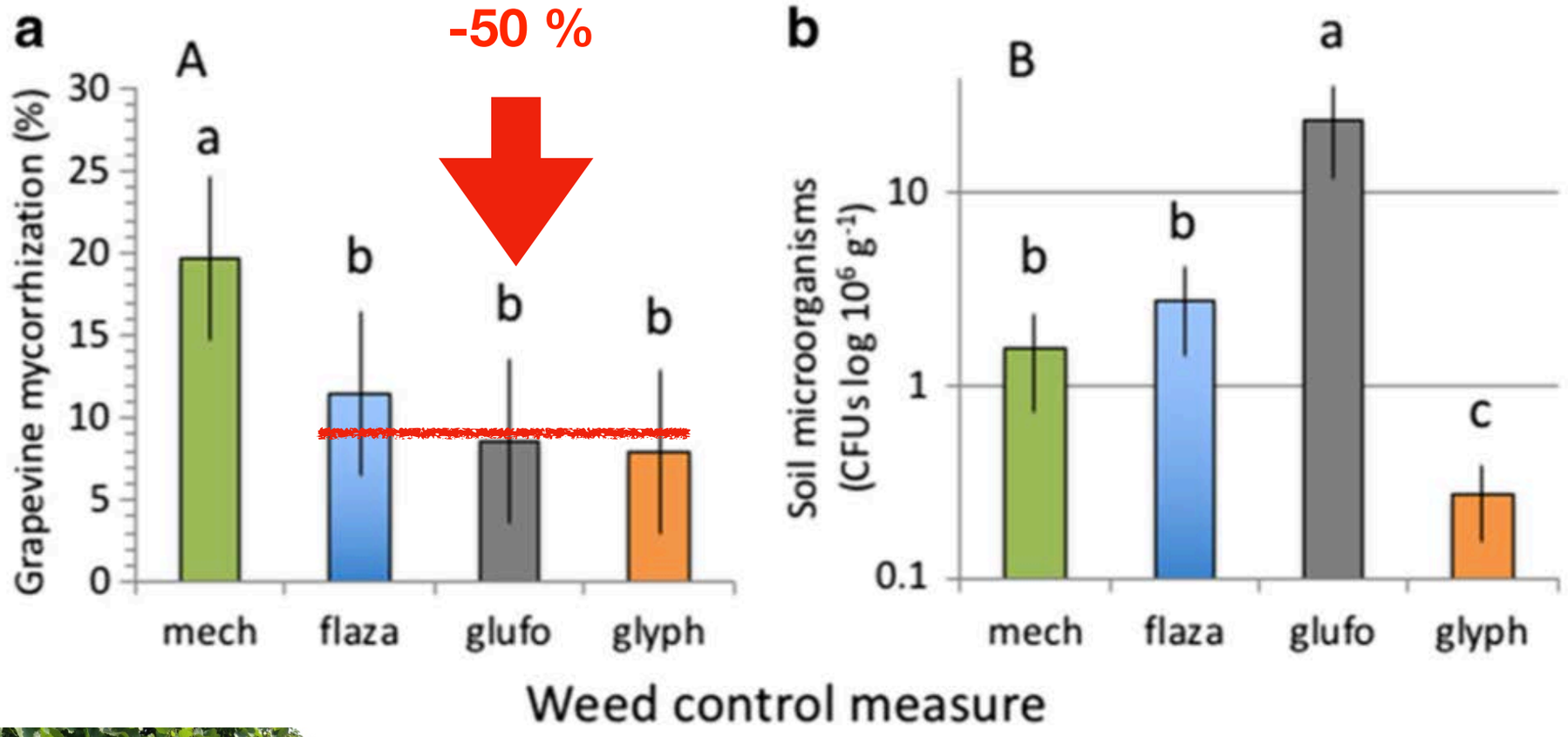


SCIENTIFIC REPORTS

Zaller et al. 2014, Sci Rep

Herbicides reduce mycorrhizae

field experiment

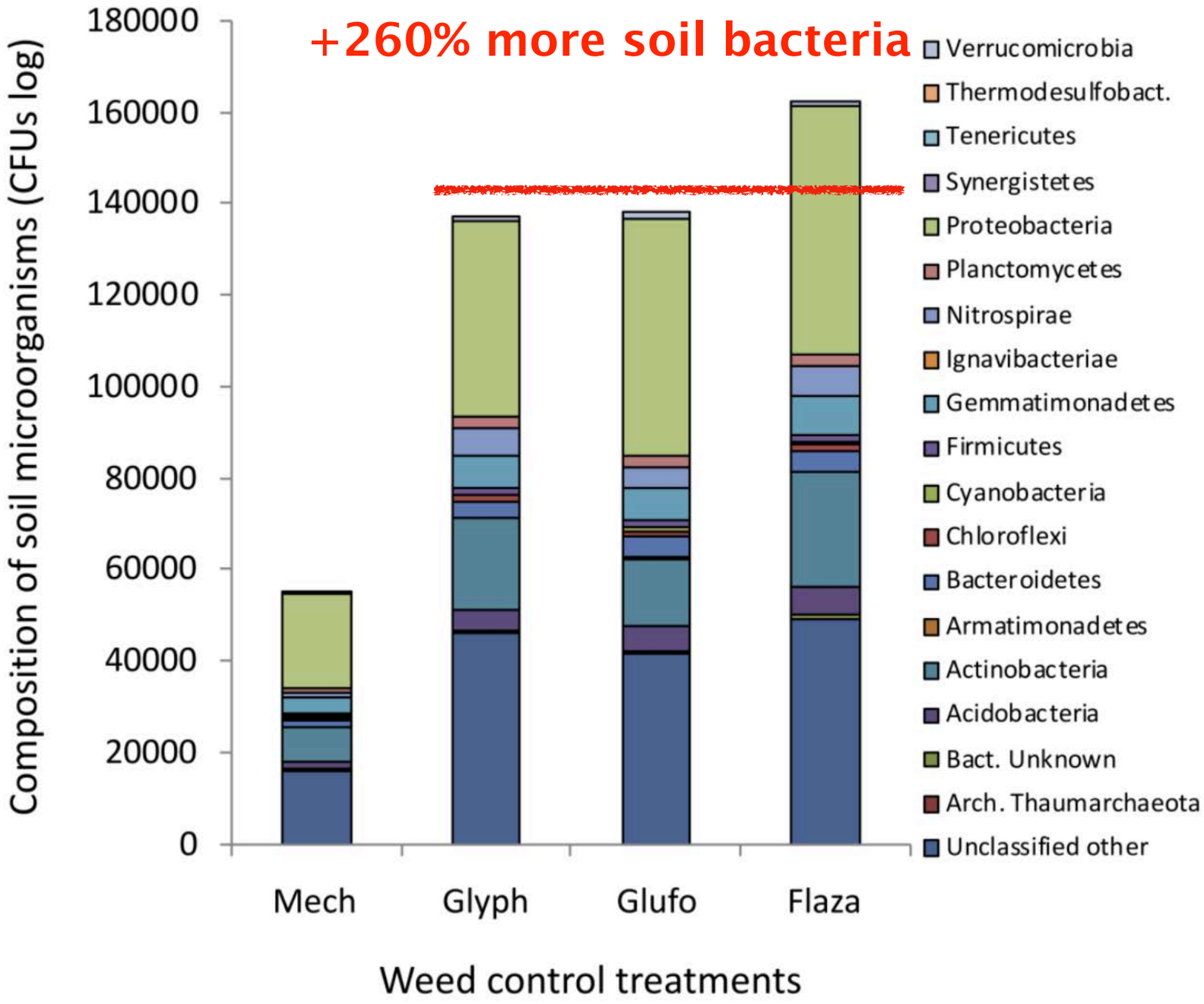


alterations of soil microorganisms

mech…mechanical weeding
flaza…flazasulfuron
glufo…glufosinate
glyph…glyphosate

Zaller et al. 2018,
Env Sci Poll Res

Herbicides alter soil microorganisms



little knowledge to many of these bacteria

Question, whether these bacteria affect wine quality?

mech…mechanical weeding
flaza…flazasulfuron

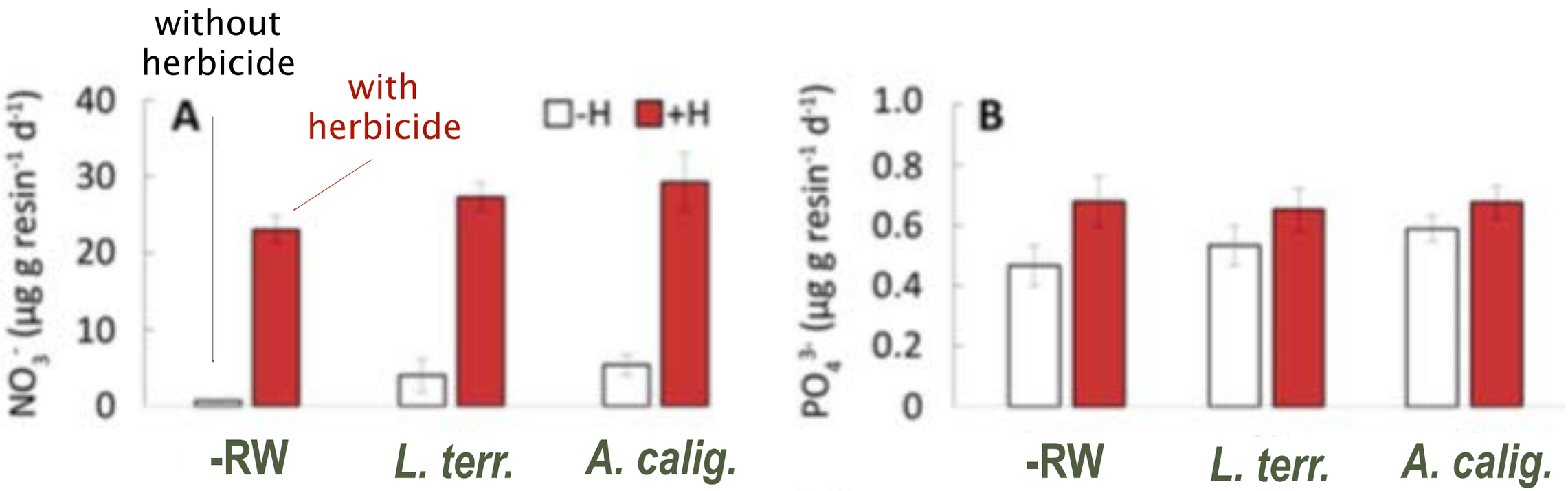
glufo…glufosinate
glyph…glyphosate

Mandl et al. 2018, Bull Env Contamin Toxicol

More soil nitrate & phosphate

Nitrate: +1592%

Phosphate: +127%



Nutrients in soil are prone to leaching into water bodies.

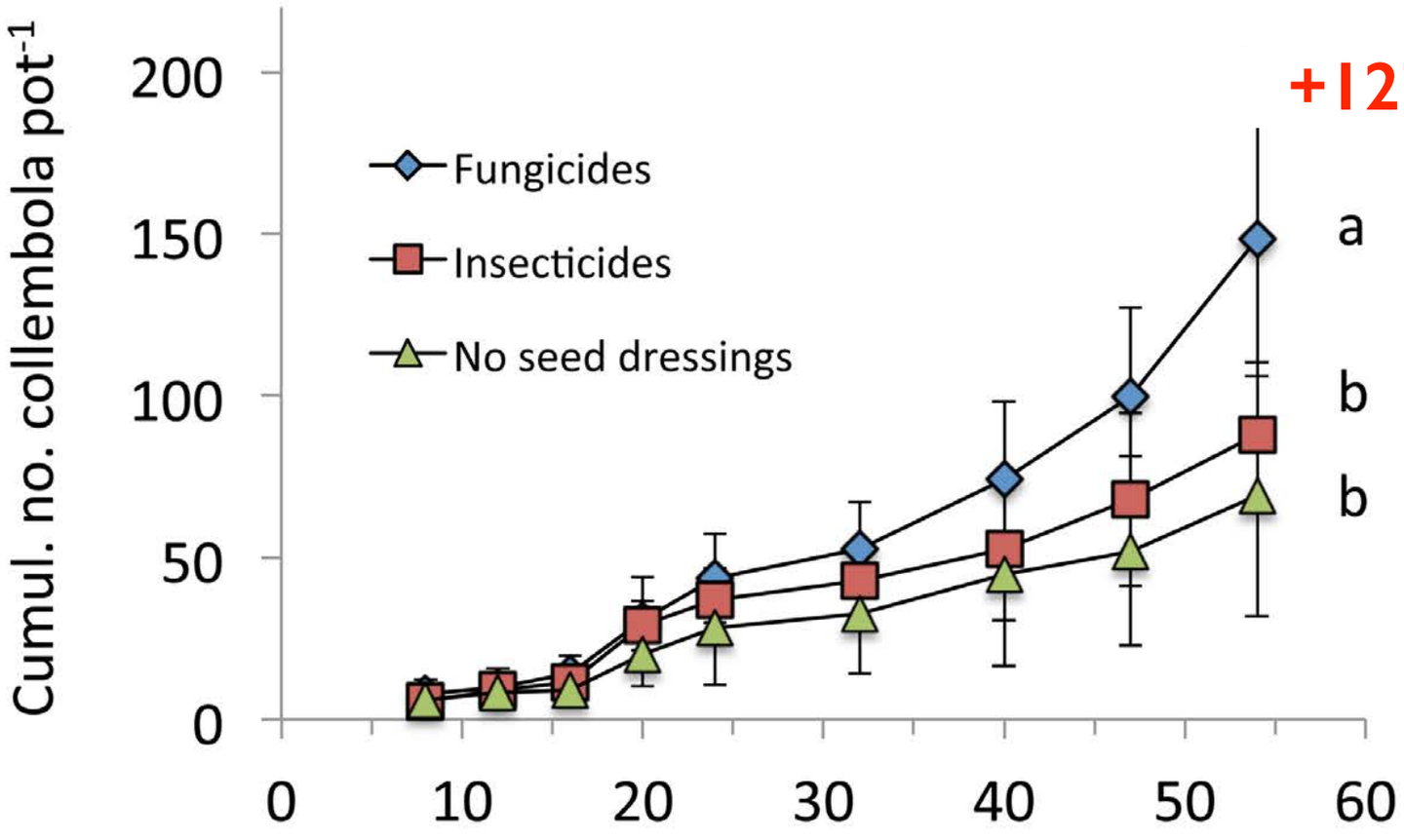
Gaupp-Berghausen et al. 2015, Sci Rep

Pesticide seed dressings

Springtails, earthworms, protozoa

Seed dressing & springtails

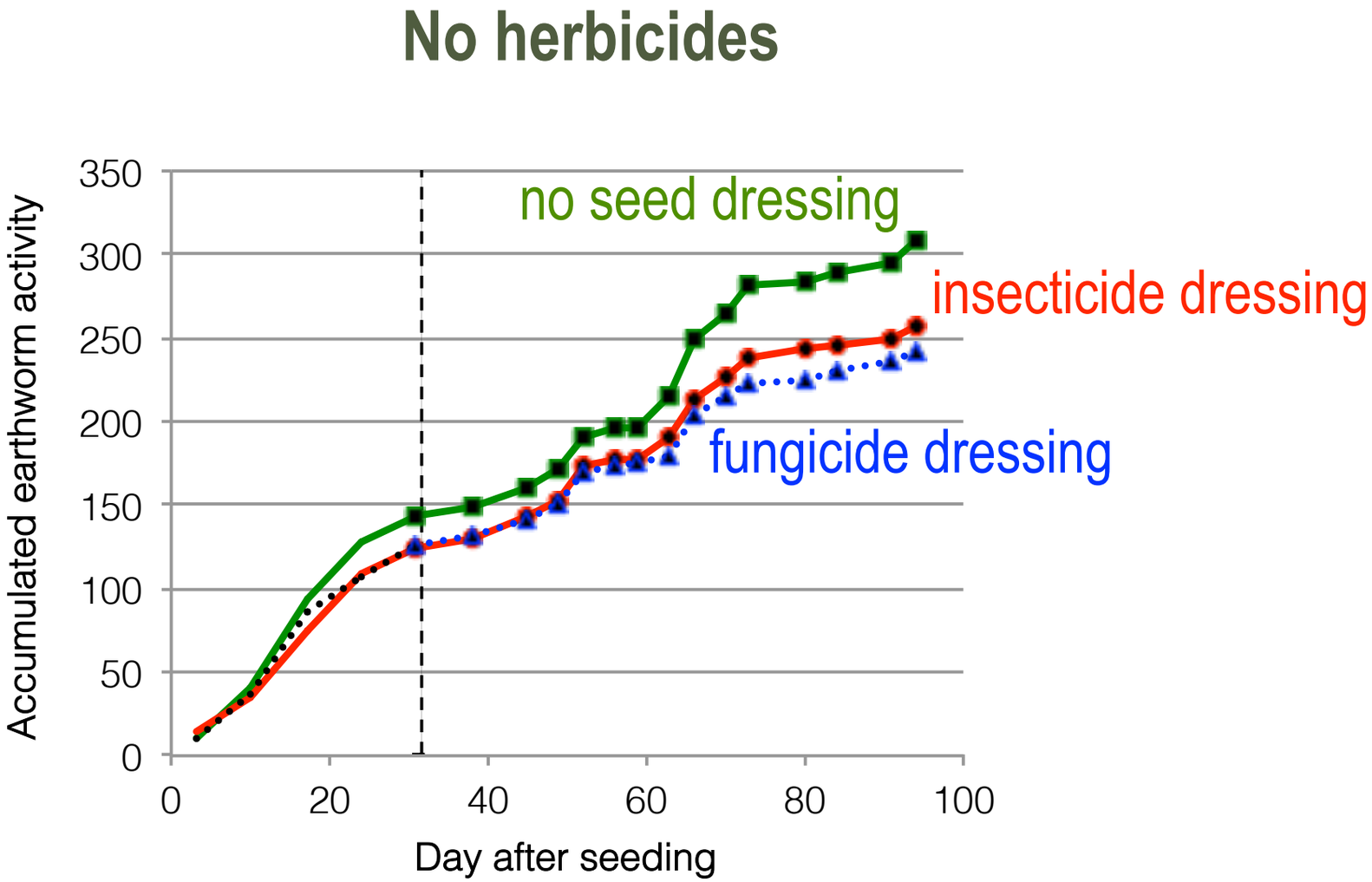
Fungicides in seed dressings drive springtails to soil surface



Sinella curviseta

Zaller et al. 2016, BMC Ecol

Seed dressing & earthworms

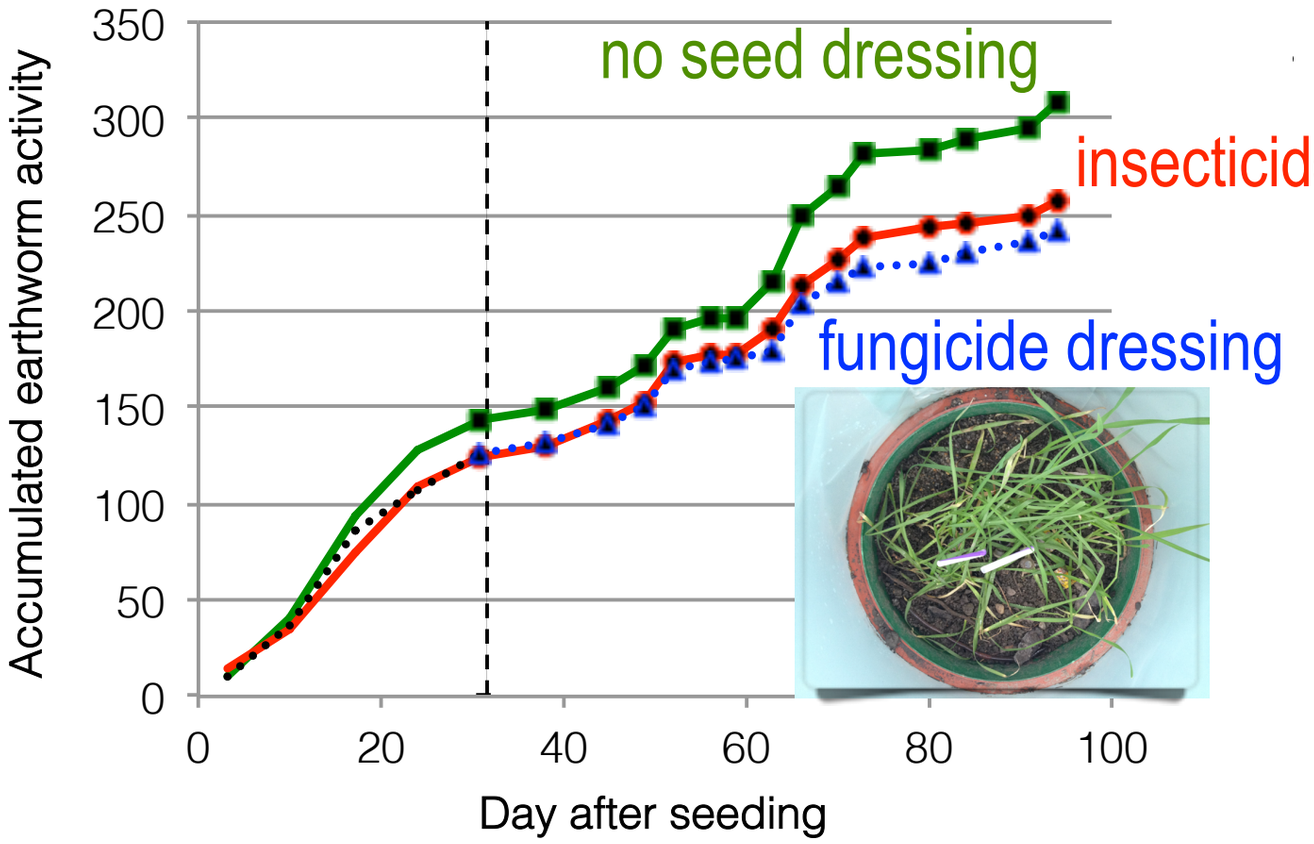


Fungicides & insecticides (neonics) in seed dressings reduce earthworm activity

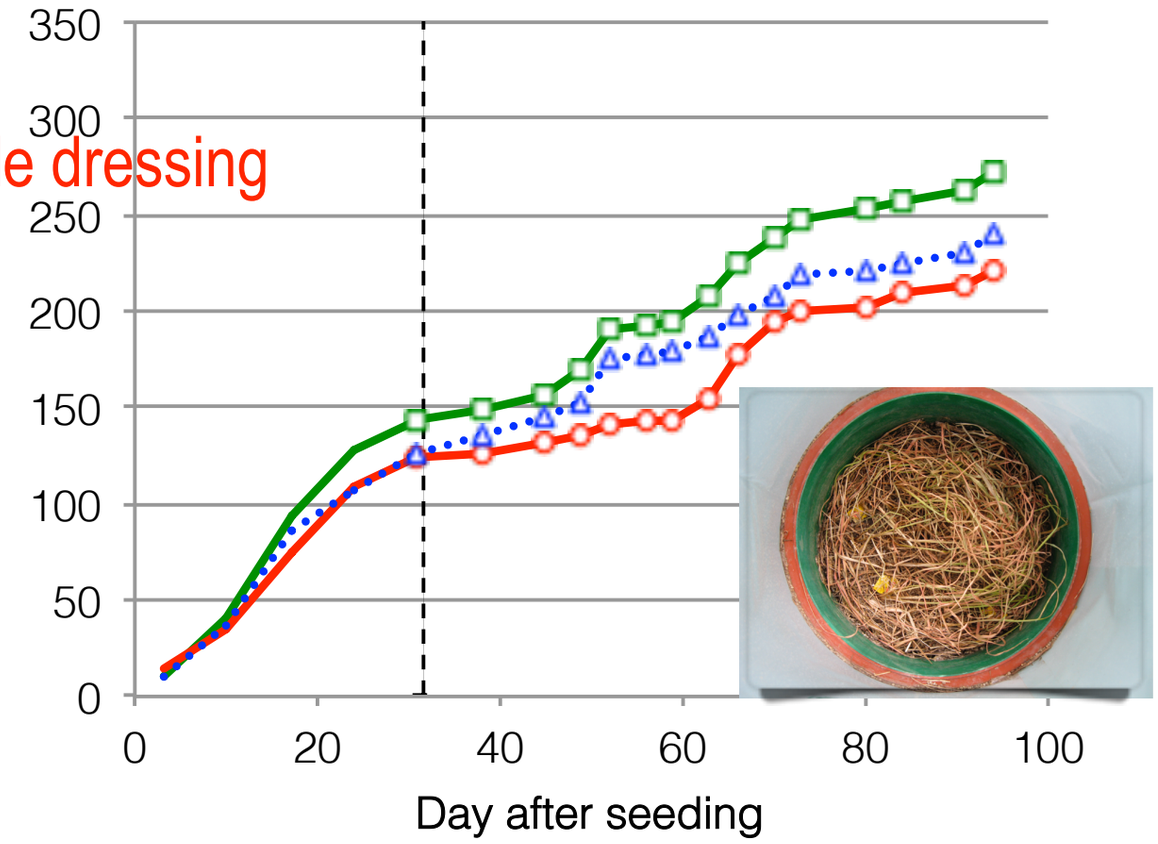
van Hoesel et al. 2017, Front Plant Sci

Seed dressing & herbicides

No herbicides



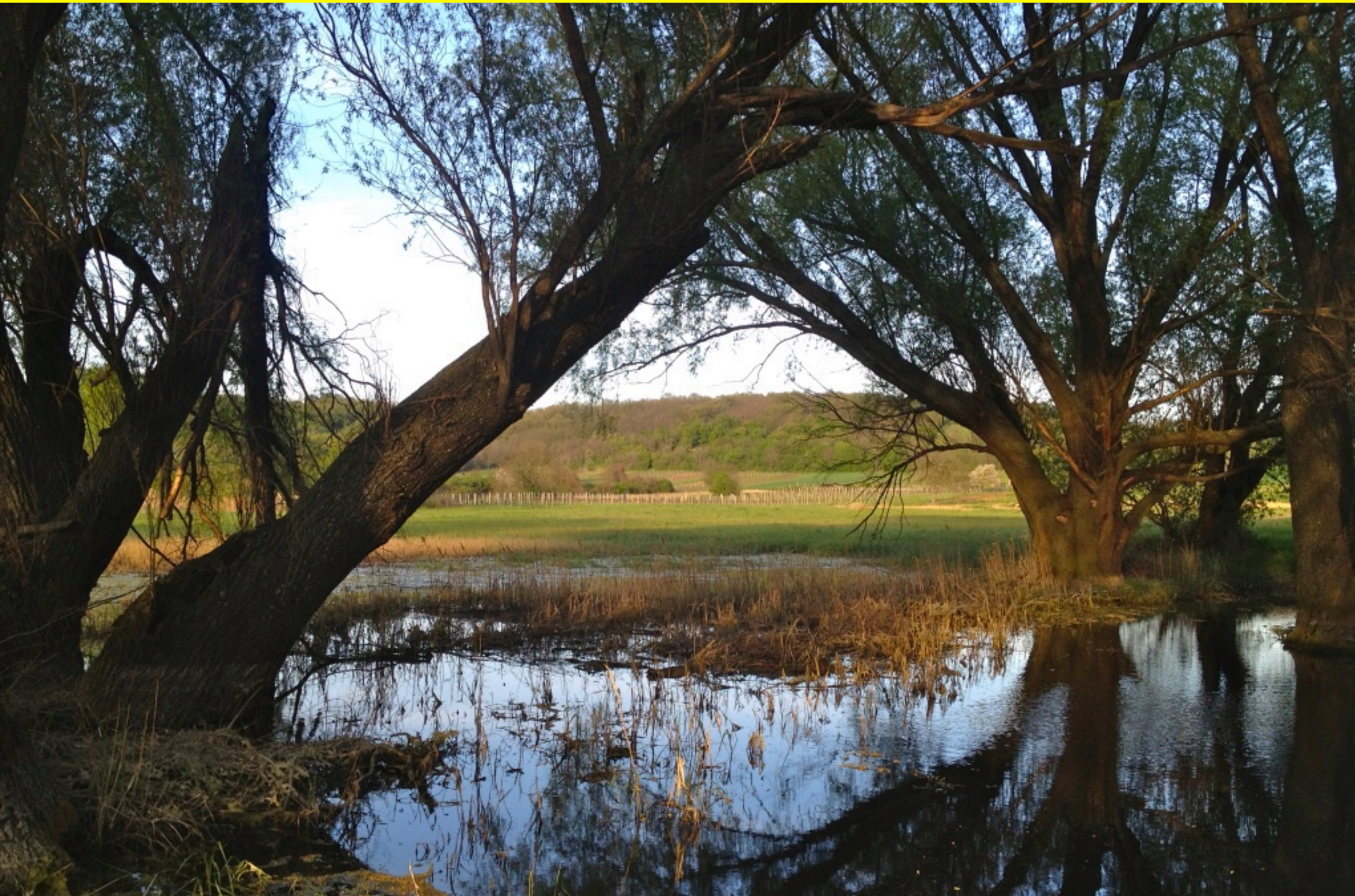
With herbicides



Herbicides reduced earthworm activity and interacted with pesticide seed dressing (cocktail effect).

van Hoesel et al. 2017, Front Plant Sci

Pesticide effects on toads

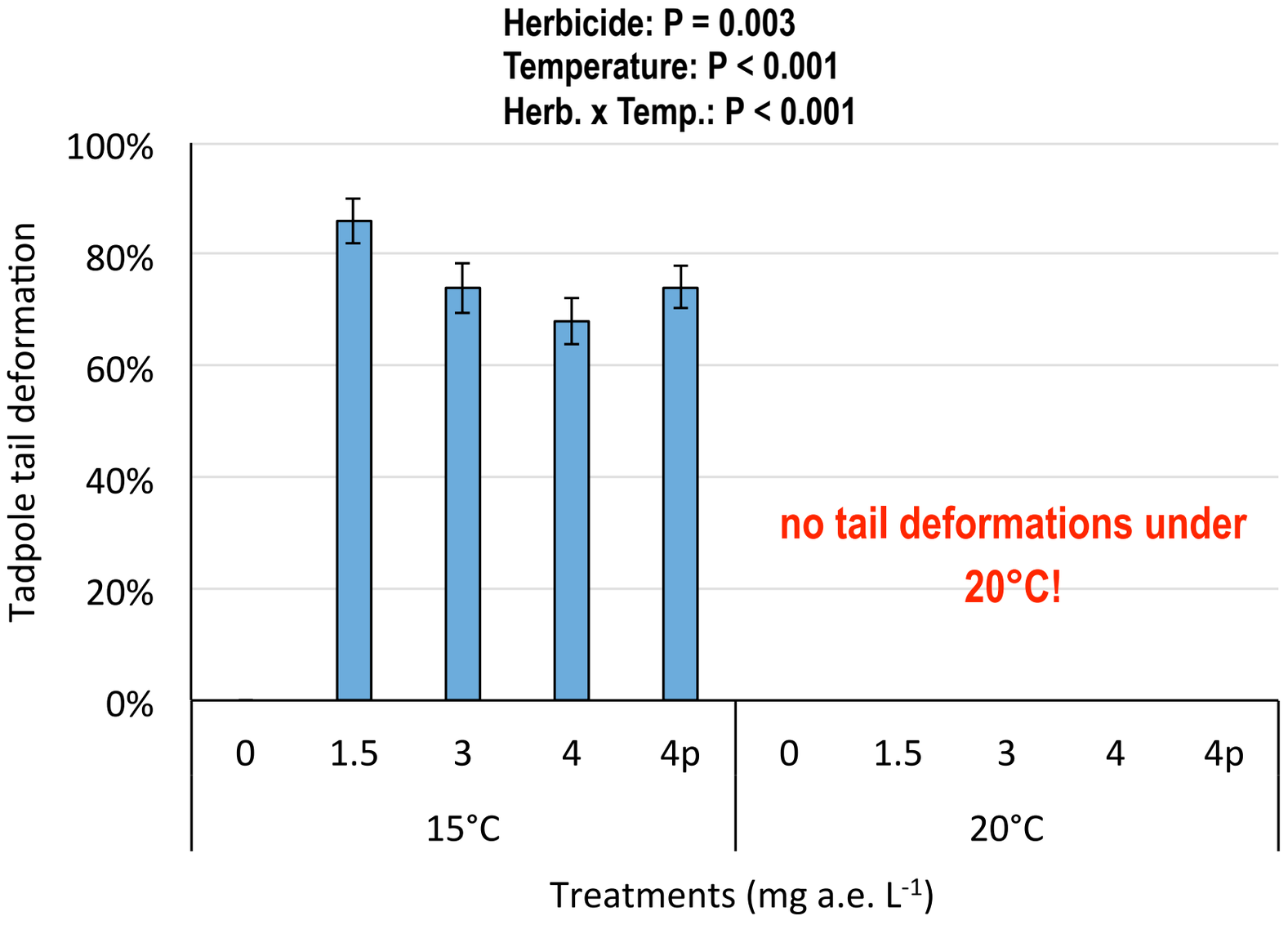


Climate chamber experiment

- climate chamber
- coal-filtered tap water
- 4 larvae of European toads (Bufo bufo) per 4 litres of water
- natural algae communities
- two temperature levels (15°C vs. 20°C)

Temp. alters herbicide effects

herbicides induce tail deformations



additional changes in algae communities

Glyphosate-concentrations:
0, 1.5, 3, 4 mg a.e./l once, 4p mg a.e./l in small doses several times

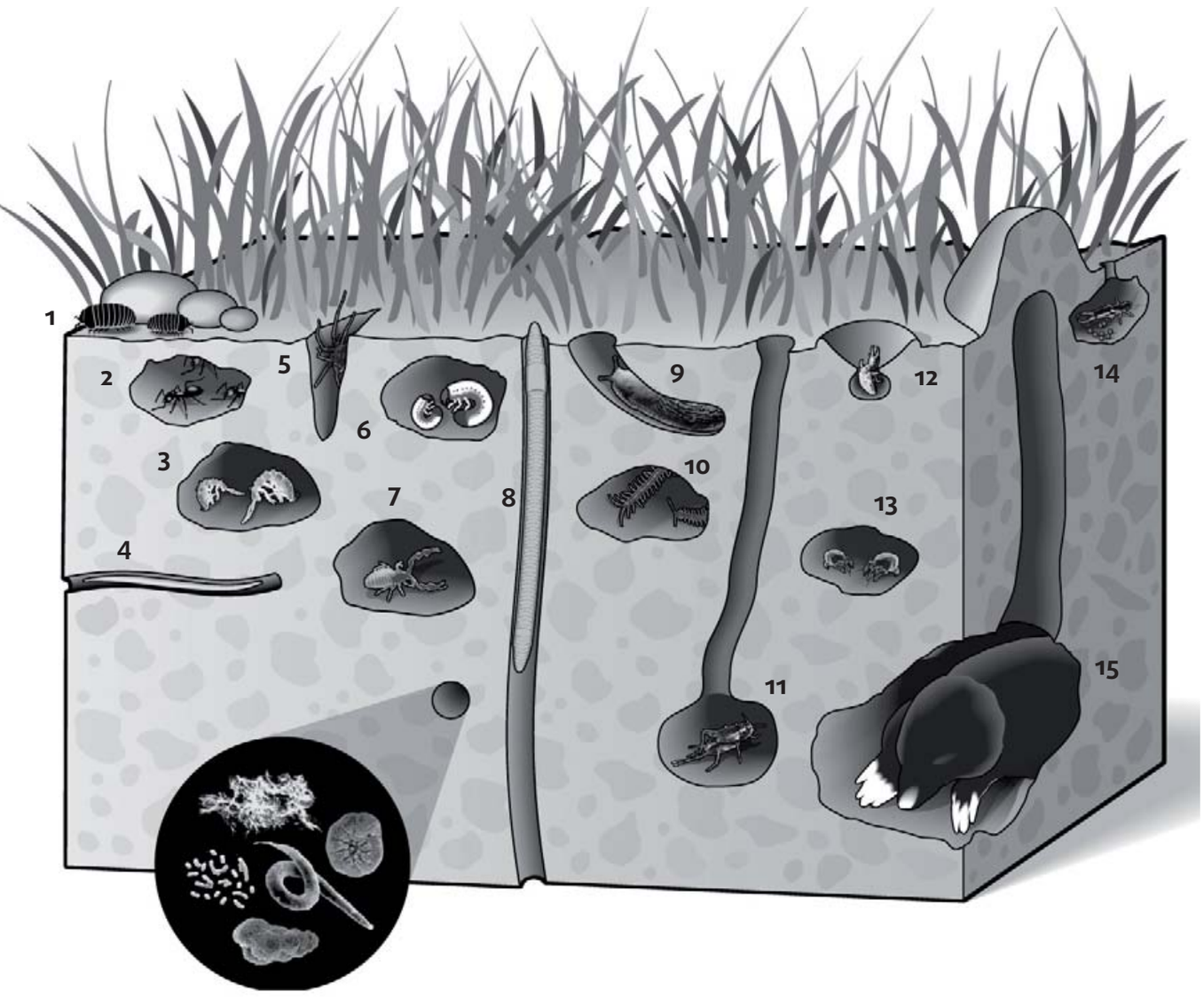
Baier et al. 2016, PeerJ

Ongoing studies

Field and pot experiments on

- commercial formulations vs. active ingredients
- interaction with soil humus content
- soil microorganisms
- ecosystem functions: infiltration, nutrient retention

Why should we care about this?



ec.europa.eu/environment/soil

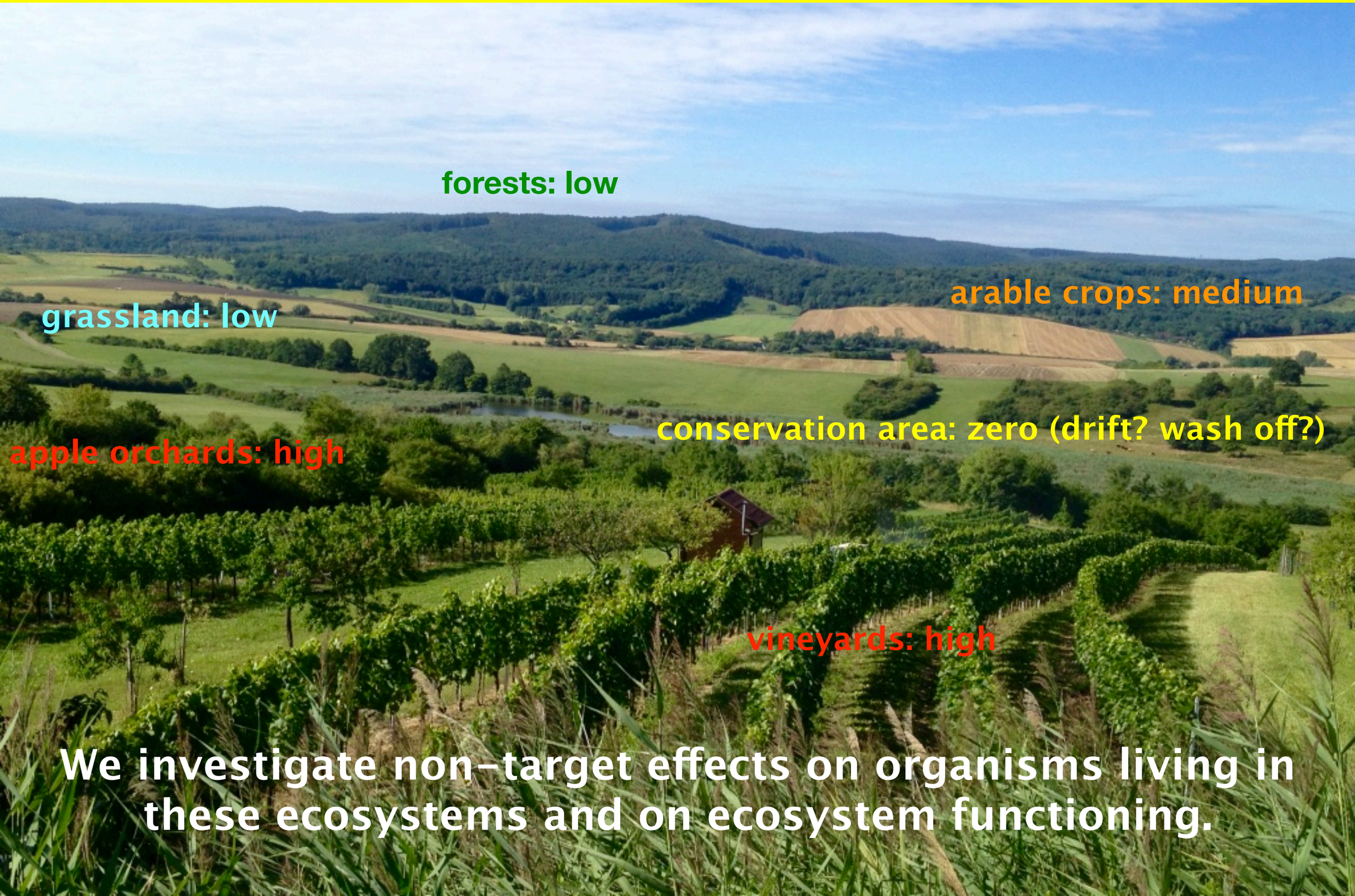
Soil biota provide many ecosystem services

- sustain soil fertility
- soil structure
- flood prevention
- CO_2 storage
- water storage and cleansing
- biodiversity reservoir
- provide healthy crops

Huge gaps in our knowledge

- multi-generational effects
- long-term effects
- pesticide accumulations in the environment
- pesticide drift (conservation area)
- pesticide use in Natura 2000
- formulations vs. active ingredients
- pesticide mixtures (cocktail-effects)
- legacy effects on rotational crops
- no post-approval or long-term monitoring
- interactions with other stressors: species competition, climate change, biodiversity loss, landscape structure…

Pesticide input in our landscape?



We investigate non-target effects on organisms living in these ecosystems and on ecosystem functioning.

Public upset against pesticides

www.multiwatch.ch

Book about pesticides

Motivation: disseminate research results.

Goal: provide facts to an emotional debate.

Extent: 240 pages, >350 references.

Translation:
Our daily poison. Pesticides – the underestimated danger.
Deuticke Verlag, Vienna.

Thanks !

For the invitation & your attention.

Contact: johann.zaller@boku.ac.at

Welcome in Vienna !

Session: Non-target effects of pesticides

Chairs: Johann Zaller & Carsten Brühl

GfÖ The Ecological Society of Germany, Austria and Switzerland

www.gfoe-conference.de

Motto of integrated pest management

„As little as possible, as much as necessary.“

No necessity of using herbicides

Lax regulations & controls

Outdated application technique

Outdated application technique