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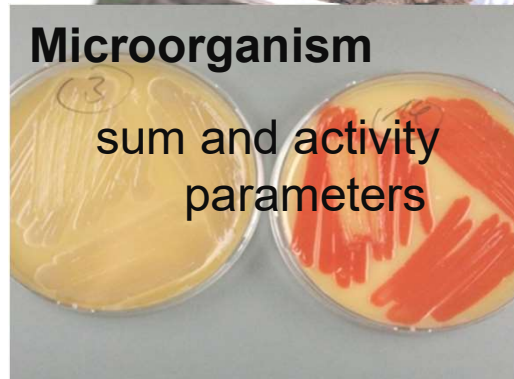
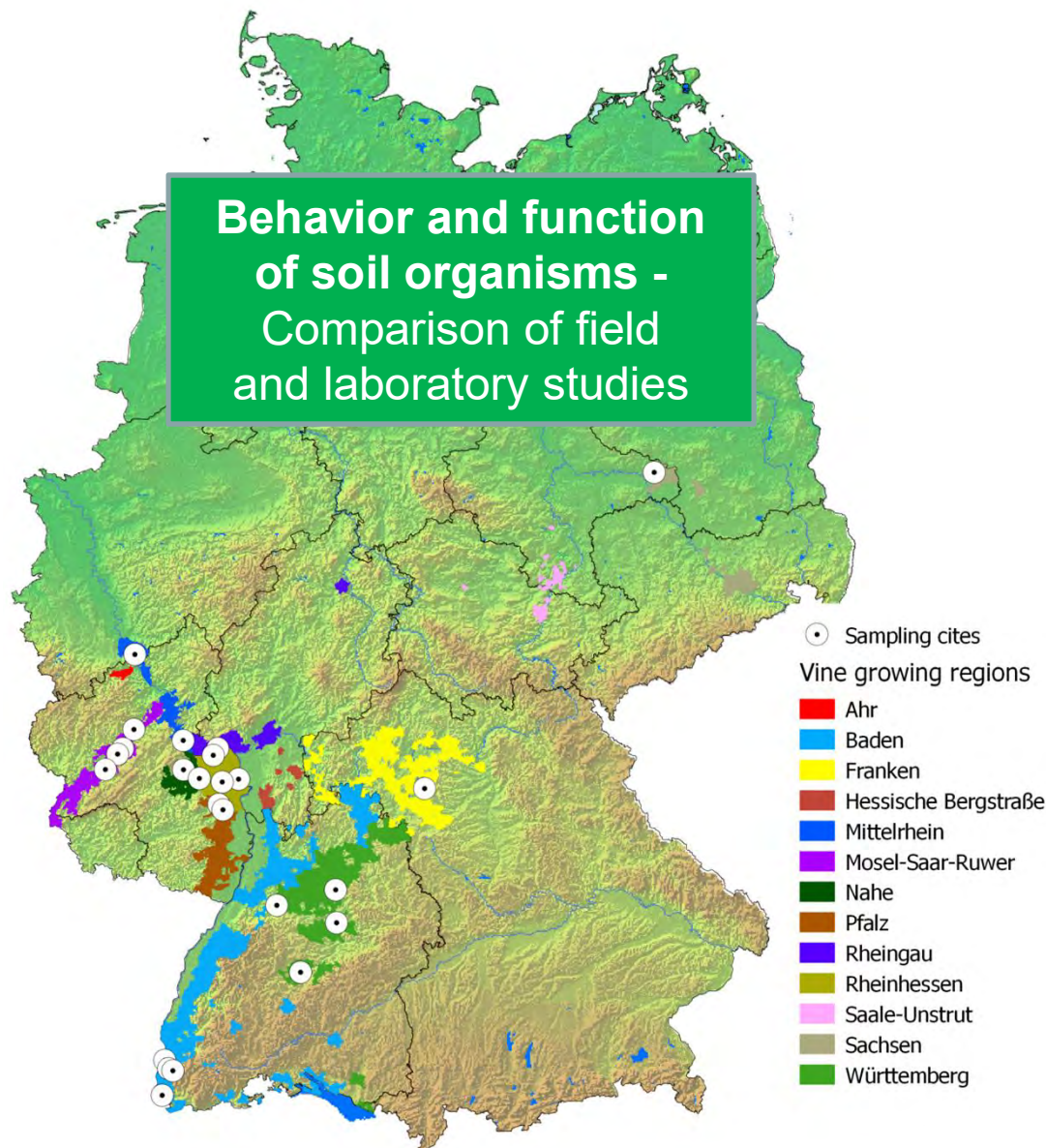
Bundesforschungsinstitut für Kulturpflanzen  
Federal Research Centre for Cultivated Plants

## **Mindert die heterogene Kupferverteilung in deutschen Weinbergsböden mögliche Auswirkungen auf die Funktion von Bodenorganismen?**

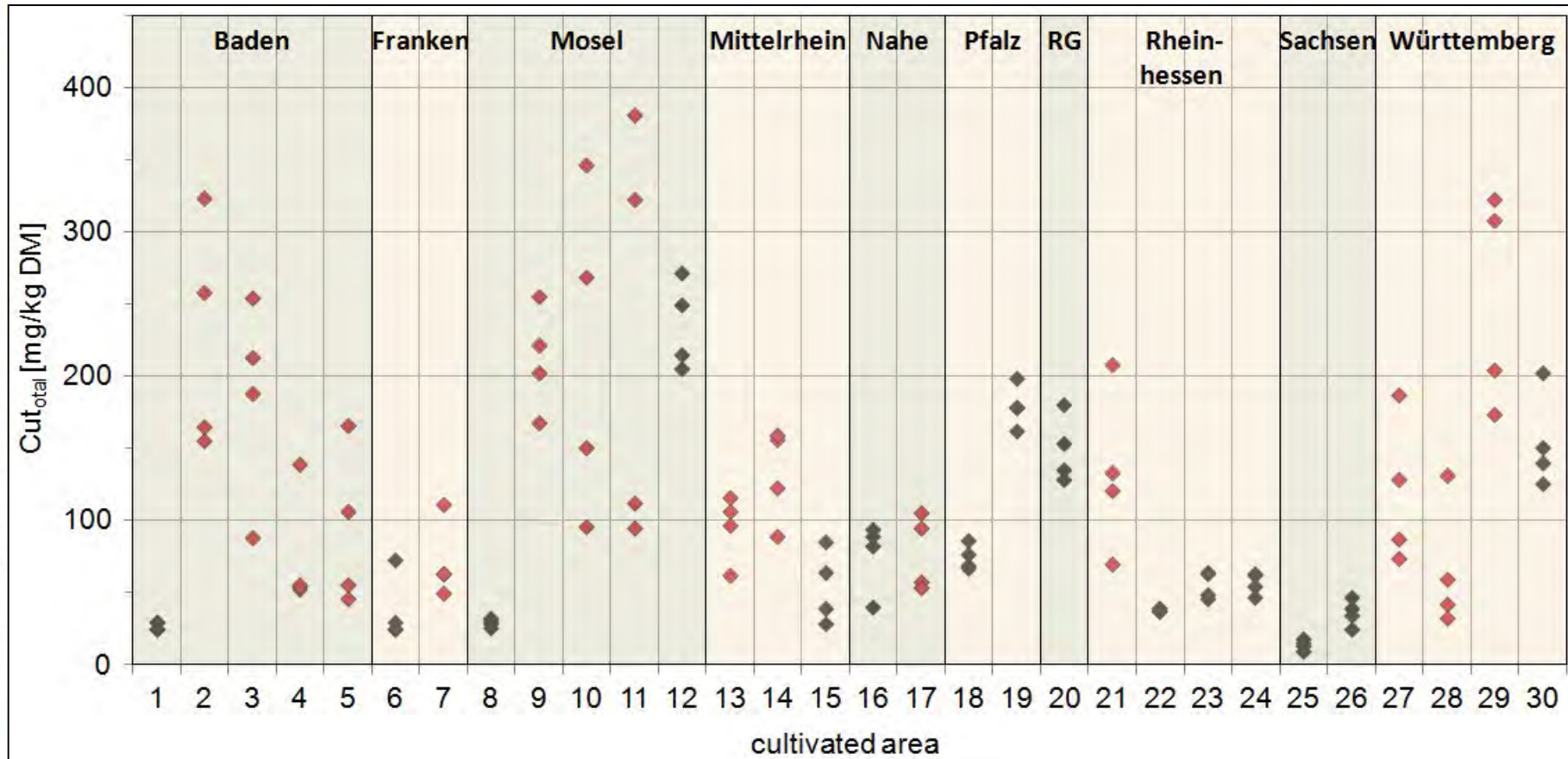
Does the heterogeneous distribution of copper in German vineyard soils reduce potential effects on the functions of soil organisms?

**Nadine Herwig, Bernd Hommel & Dieter Felgentreu**

# Copper research at JKI-ÖPV: 2009 to 2014



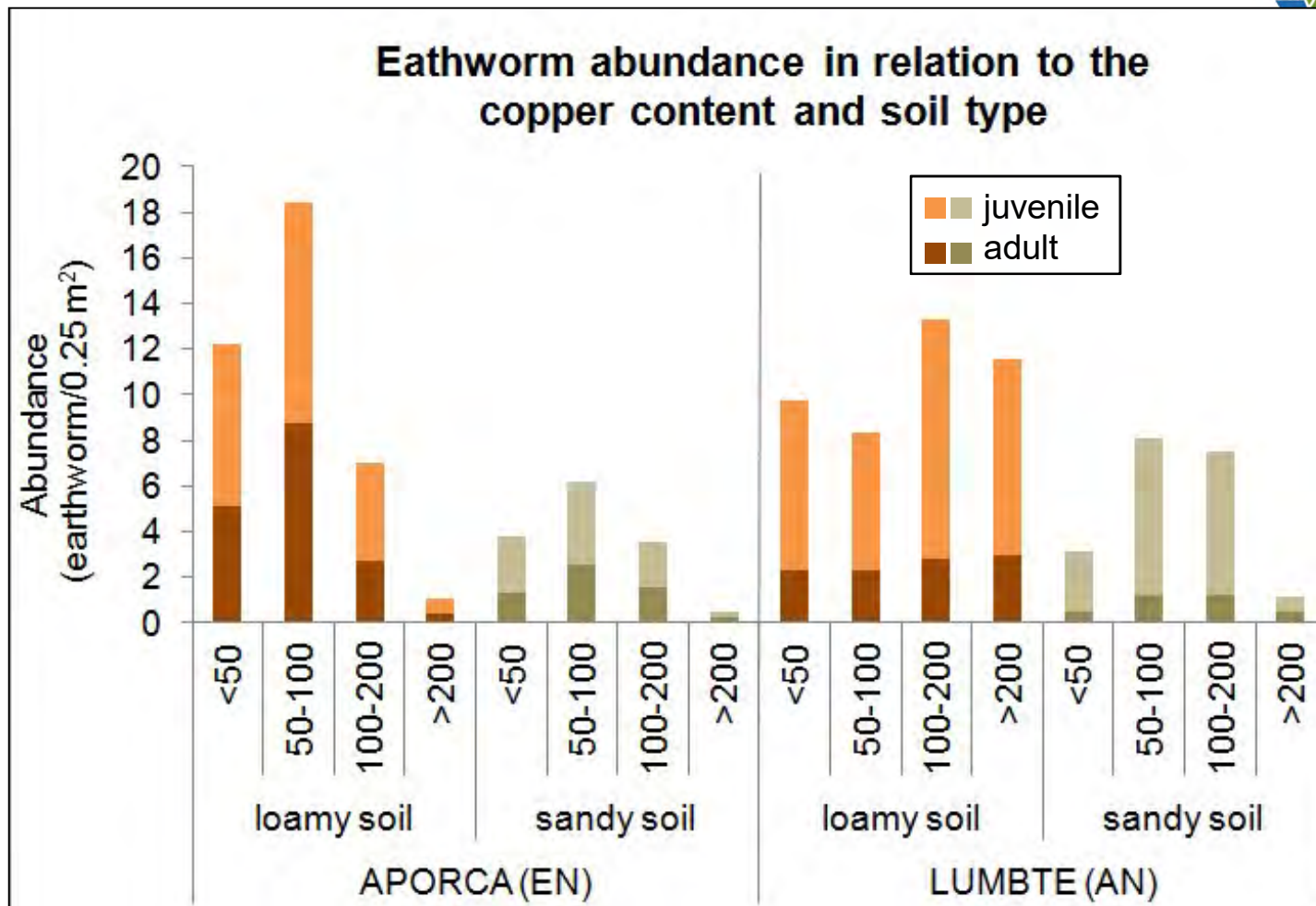
# Copper distribution per sample point in the field



1. Heterogeneous copper distribution is common.
2. The older a yard, the more often a wide range.

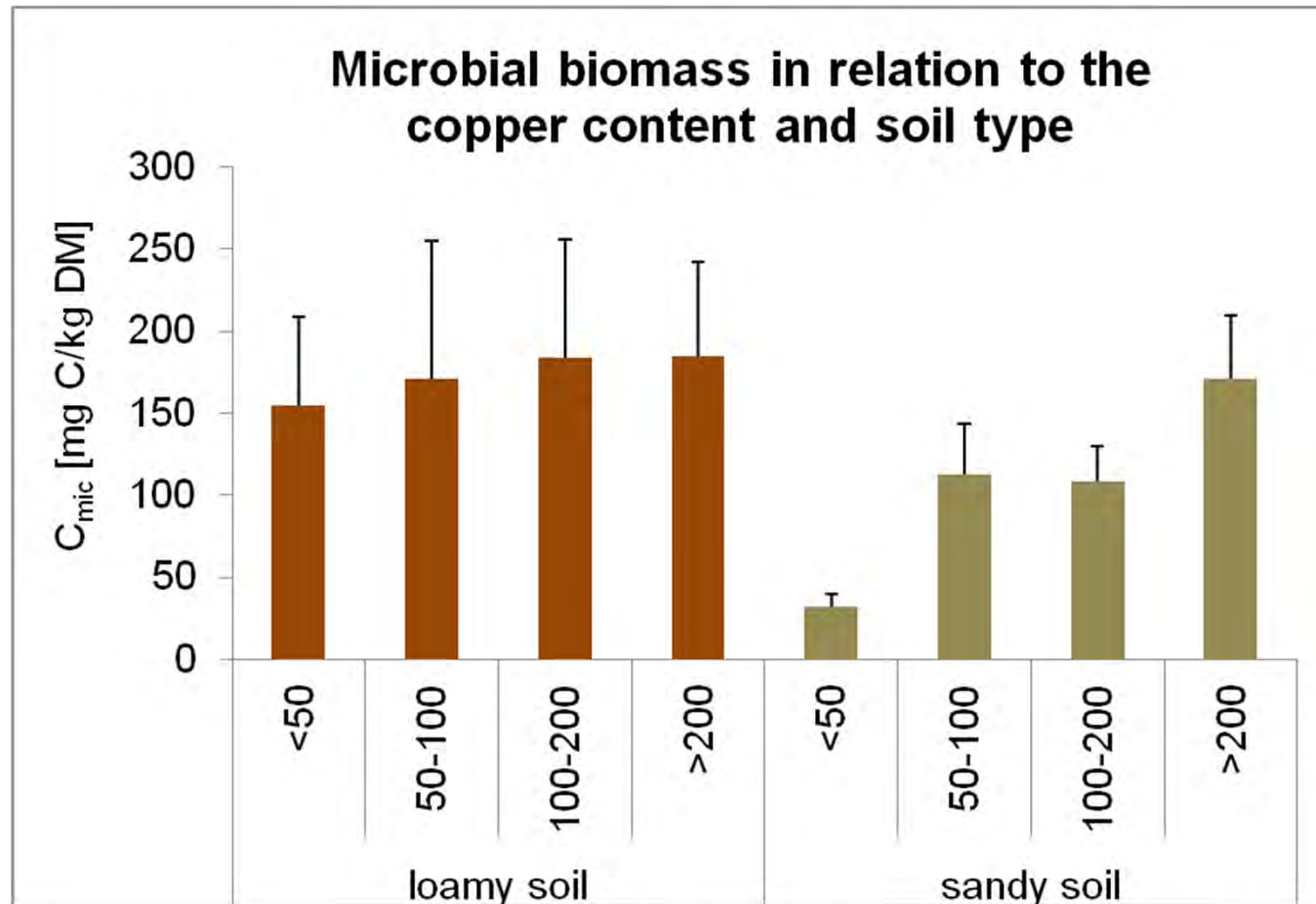
$Cu_{total}$	< 100	100 - 200	> 200
Proben (n = 120)	66	34	20

## Impact on earthworm abundance



1. Copper content and soil type take more influence on endogeic earthworms than anecic species.
2. Juveniles don't seem more susceptible than adults.

## Impact on microorganisms



1. Copper impacts on microorganisms couldn't be observed.
2. Maybe, microorganisms can adapt and/or tolerate for higher copper contents.

**Possible ideas to explain impacts of the heterogeneous copper distribution on soil organisms for risk assessment.**



- Laboratory biotests for
- earthworms behavior, growth and reproduction
  - functions of soil microorganisms

# Biotests in altered soils



Code	soil origin	pH	Me <sub>KW</sub> [mg/kg DM]			Me <sub>NH4NO3</sub> [mg/kg DM]			soil	Soilt texture [%]			OM [%]	C [%]	N [%]	C/N	KAK [cmol/kg]
			Cu	Cd	Zn	Cu	Cd	Zn		sand	silt	clay					
FR	vineyard	7.4	80	0.2	56	0.7	<LOD	0.02	Lt3	25	37	38	6.0	1.8	0.08	23	10
RH	vineyard	7.4	138	0.4	81	1.0	<LOD	<LOD	Lu	15	63	22	5.4	5.8	0.14	41	14
MO	vineyard	5.4	368	0.5	113	1.5	<LOD	0.02	Sl4	54	29	17	7.5	2.9	0.27	11	18
Hett	arable	6.9	725	16	2257	2.8	0.2	6.1	Ul3	11	70	19	8.2	3.4	0.27	13	21
DD	arable	5.0	4	0.2	25	0.01	<LOD	0.40	Slu	45	47	8	1.5	0.5	0.06	9	4
LB	arable	6.6	24	0.9	103	0.1	<LOD	0.06	Sl3	77	14	9	2.5	1.3	0.10	13	n.d.

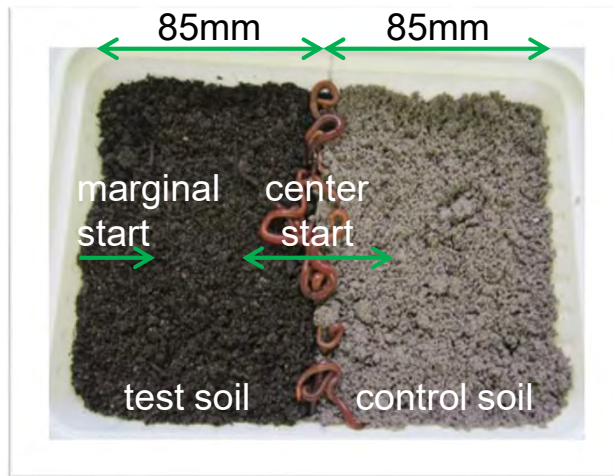
# Avoidance behavior biotest



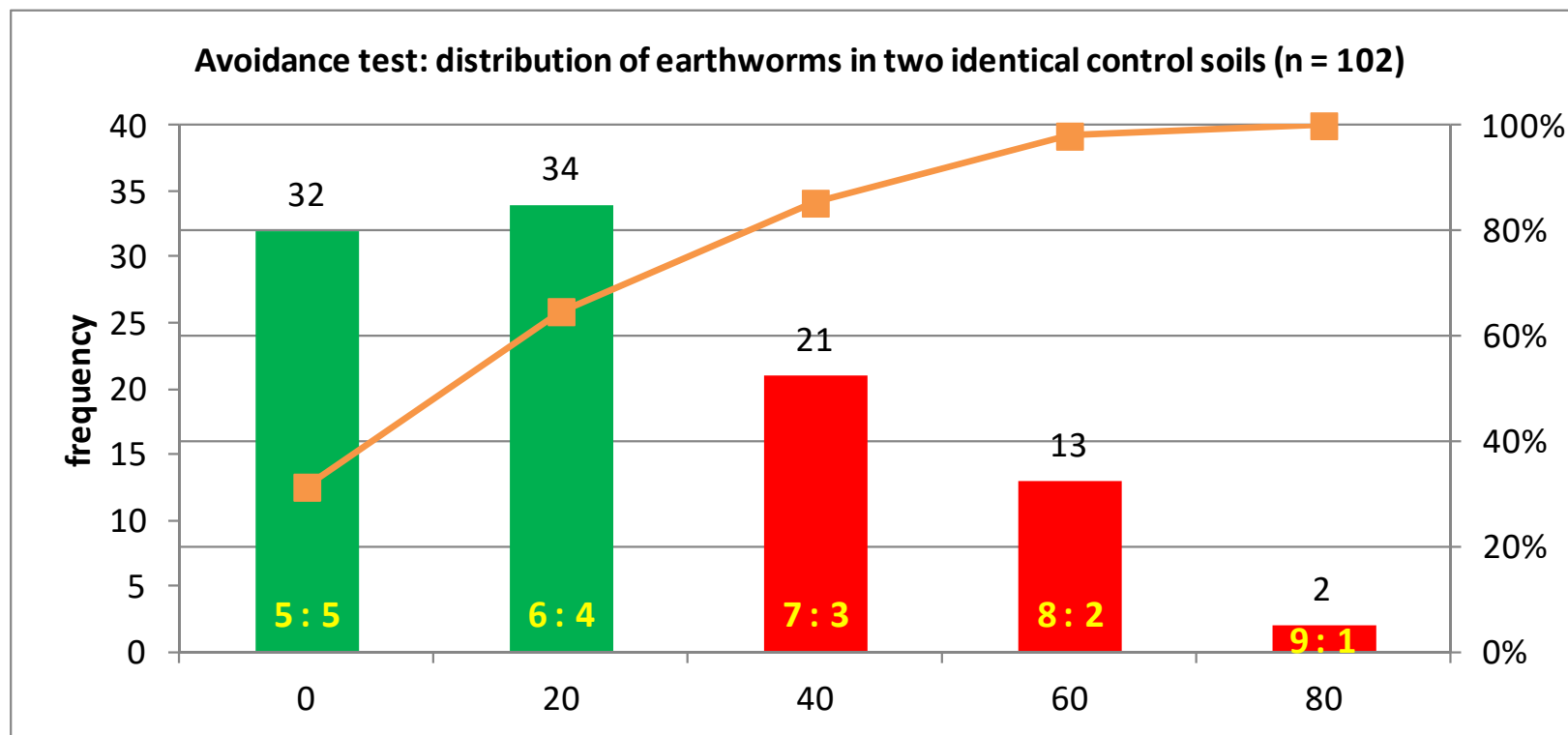
*Eisenia andrei*



non-adapted species

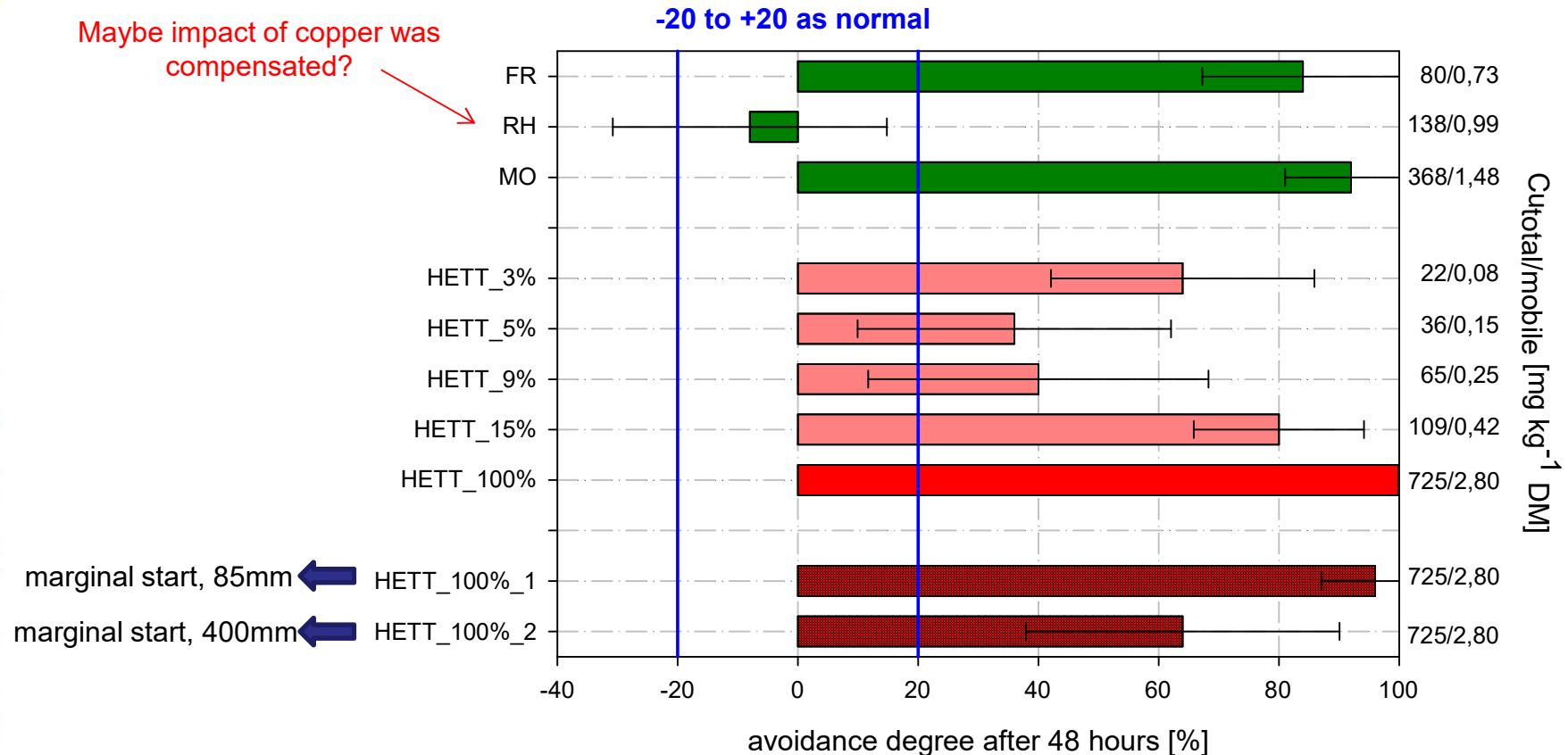


## Avoidance behavior (Robustness of the test)



In  $\frac{2}{3}$  of all samples, earthworms were optimal distributed.

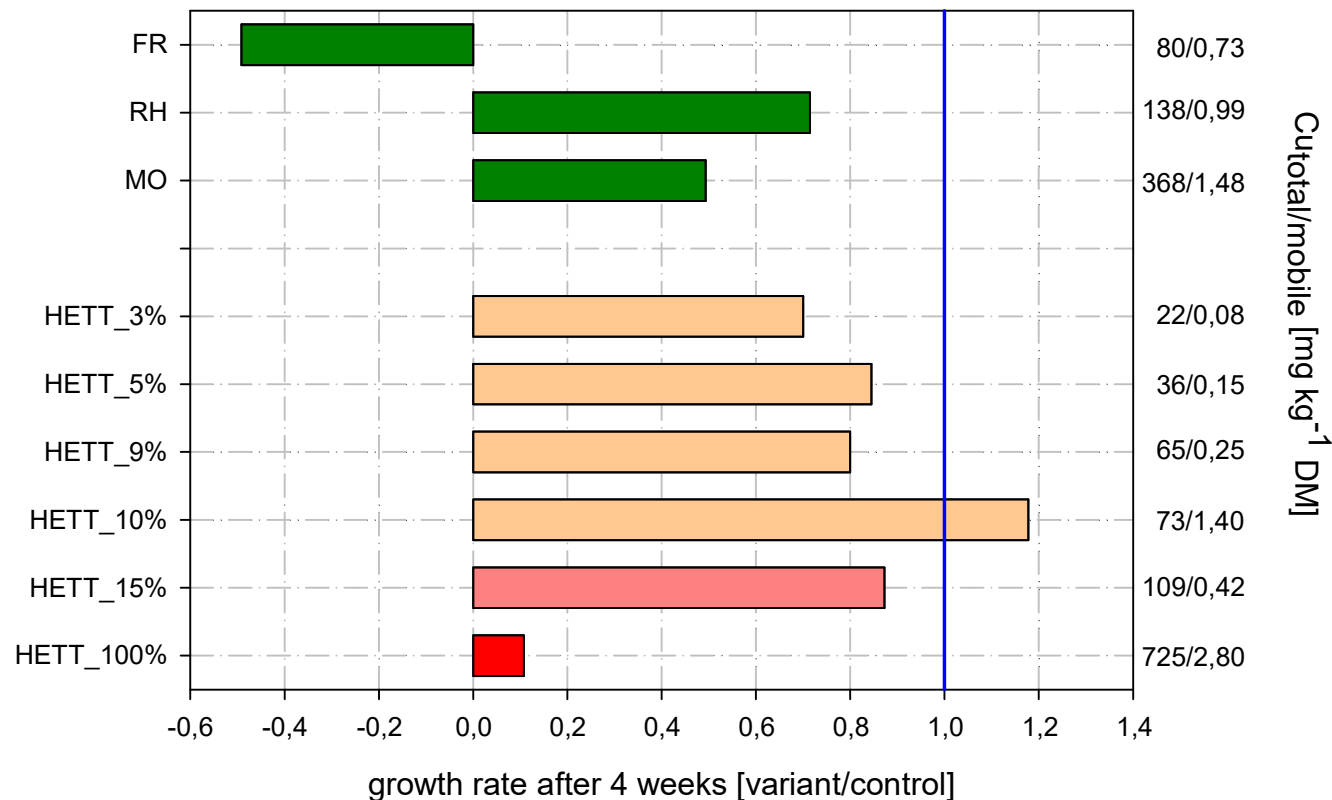
# Avoidance behavior for “self-protection”



## Copper doesn't kill earthworms!

It chases earthworms from the “stress zone” into the “comfort zone”.  
BUT in the fields, this depends on heterogeneous copper distribution.

## Relative performance of **growth rate** of earthworms in copper contaminated soils

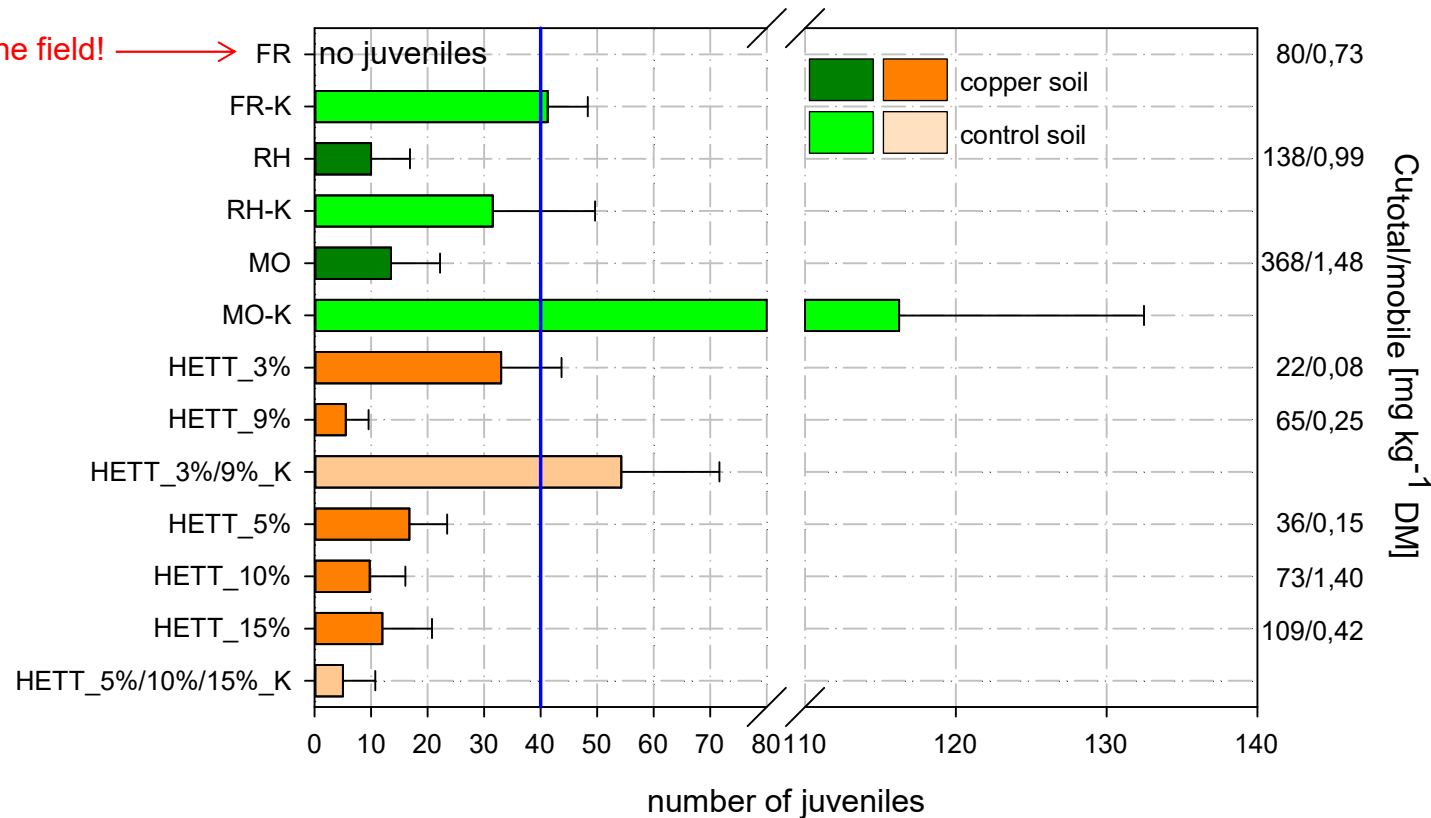


1. Growth of earthworms is drastically reduced by copper (and other traits?).
2. There was NO mortality (both on adults and juveniles) observed, even by high copper contents.

# Reproduction of earthworms in copper contaminated soils

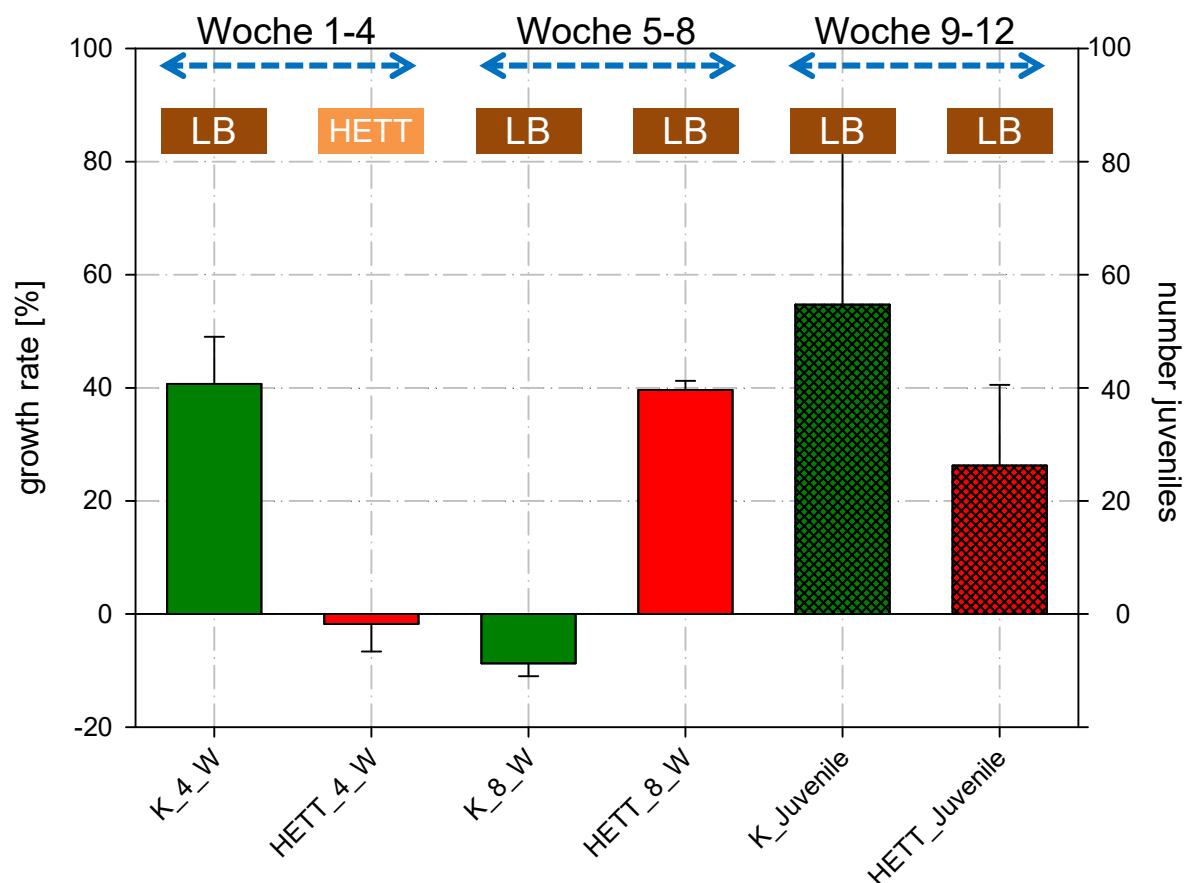


Similar to the field! →



Reproduction of earthworms is reduced, even by low copper contents.

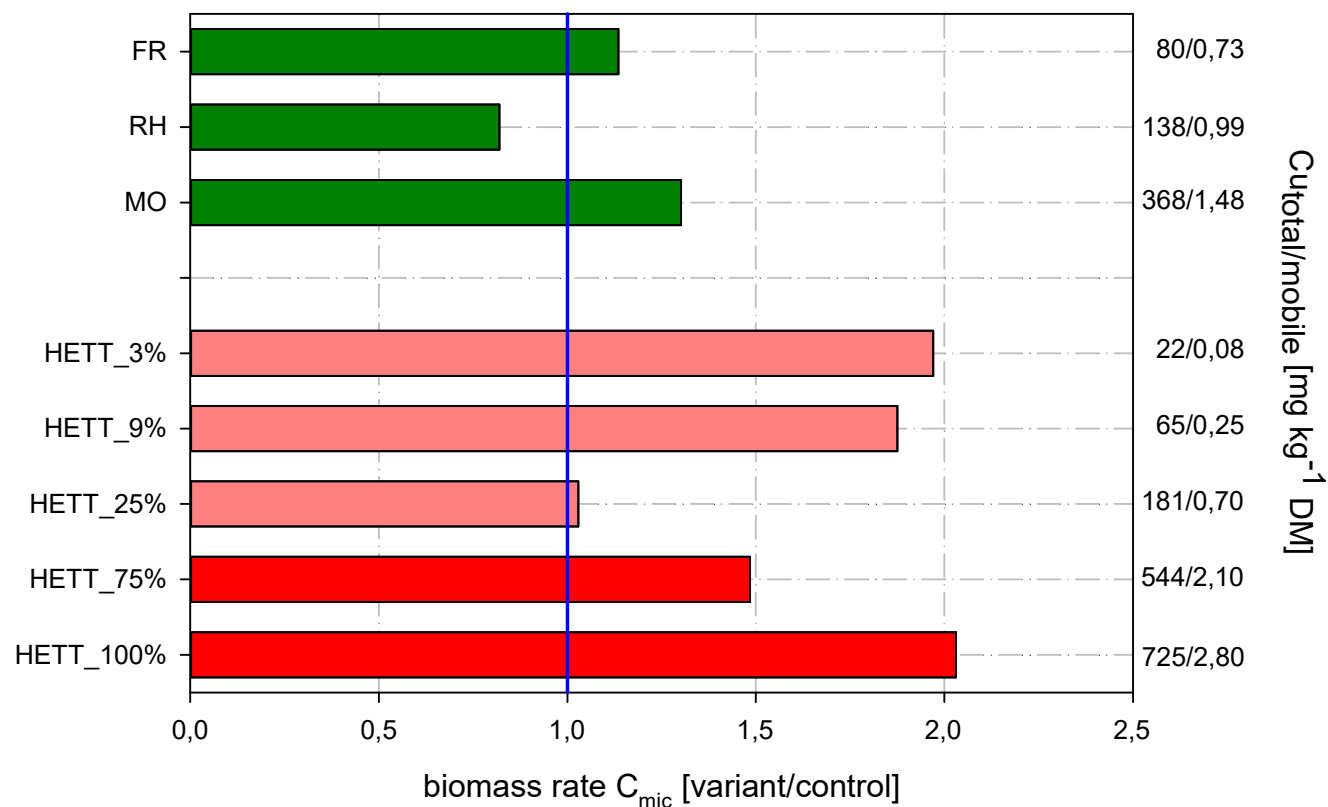
## Growth rate and reproduction after transferring into friendly soil after 4 weeks



Copper impact on growth and reproduction of earthworms is reversible under “comfortable” soil condition.

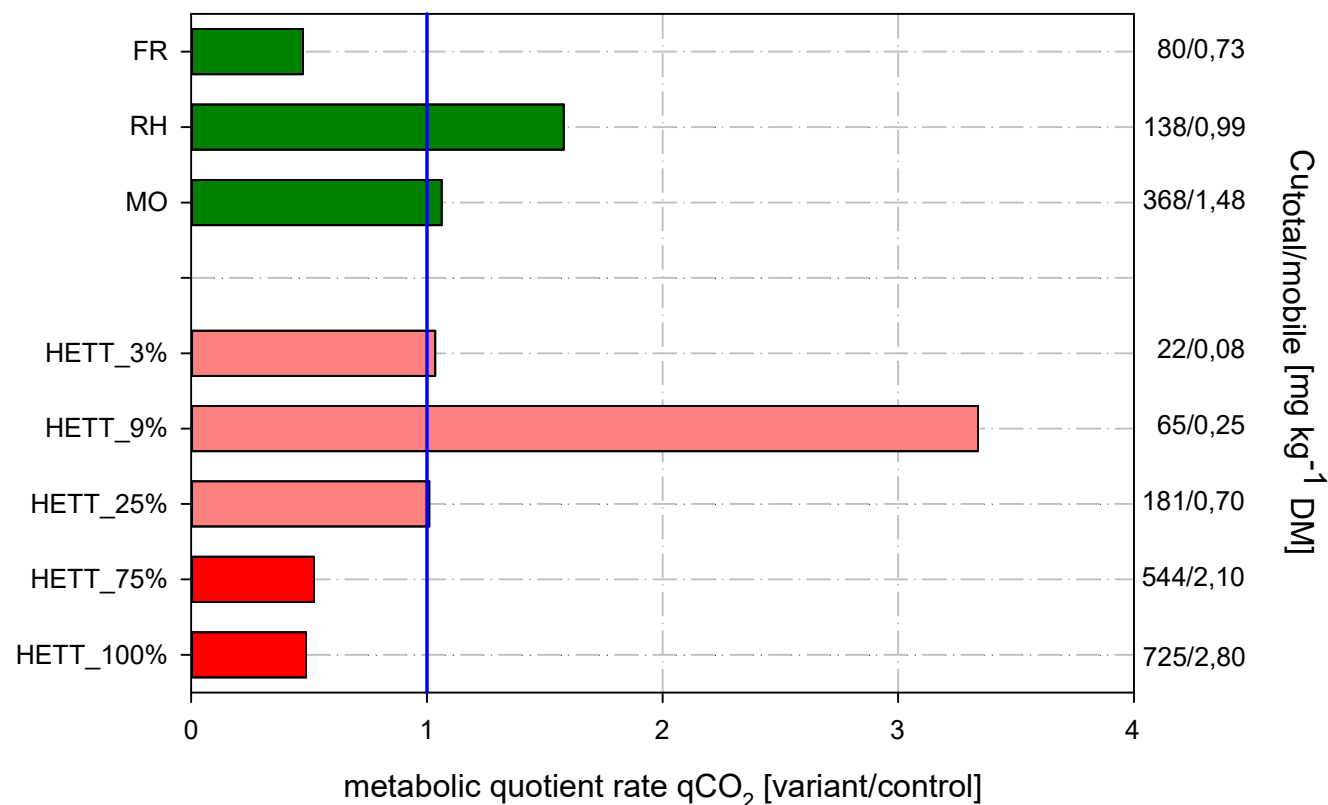
# Relative performance of microbial biomass

[mg C \* kg<sup>-1</sup> DM]



Microorganism population adapts to high copper contents.

# Relative performance of microbial metabolic quotient [mg CO<sub>2</sub>-C\* h<sup>-1</sup> \*g<sup>-1</sup> C<sub>mic</sub>]



Soil conditions (carbon, organic matter content, soil type) take a higher impact on microorganism behavior than copper.

# Does the heterogeneous distribution of copper in German vineyard soils reduce potential effects on the functions of soil organisms?



**YES!**

Heterogeneous copper distribution within a sampling area **supports resilience** of soil organism populations, because:

- Soil organisms can handle soil copper contents (tolerance, avoidance)
- Earthworm can reproduce in areas with lower copper contents
- Microorganisms don't show constraints in their function (after decades of living together with copper)

**BUT we need...**

- Monitoring concepts for endogeic earthworms at areas of higher copper contents (> 200 mg Cu<sub>total</sub>/kg)
- Maintain comfort zones at cultivated areas to compensate effects of higher copper areas to soil organisms (for example targeted application technique, site specific management in hot spot areas)

The authors are very grateful to all supporters for assistance in the field and lab. They all did a great job!

Thank you for your attention!

BÖLN

Bundesprogramm Ökologischer Landbau  
und andere Formen nachhaltiger  
Landwirtschaft

ptble

Projektträger Bundesanstalt  
für Landwirtschaft und Ernährung