EFFECTS OF MCPA AND DIFENOCONAZOLE ON GLYPHOSATE DEGRADATION AND SOIL MICROORGANISMS

Philipp Mäder[1], Fabian Stache[1], Lisa Engelbart[3], Carolin Huhn[3], Zuzana Hochmanová[2], Jakub Hofman[2], Christian Poll[1], Ellen Kandeler[1]

BACKGROUND

Soil microorganisms are among the first non-target organisms in contact with pesticides and the major degraders of the chemicals. Interactive effects of multiple pesticides on soil microorganisms are suspected [1]. Studies on the effects of pesticides on specific functions by microorganisms such as the degradation of the pesticides and substrates are scarce.

AIMS

- Mechanistic understanding of pesticide interactions with soil microorganisms
- Focus on the specific microbial function of glyphosate degradation

SETUP

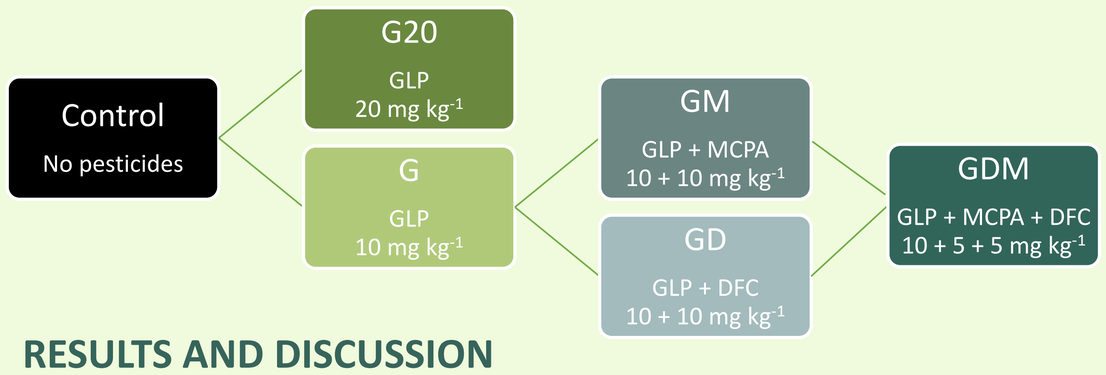
- Soil: Loess-derived stagnic Luvisol (silty loam, pH 7.0, SOC 1.21 %)
- Pesticide carrier: Burned sand or direct application
- Pesticide solvent: Water* or methanol**
- Incubation in microcosms (56 days, 20°C)

PESTICIDES

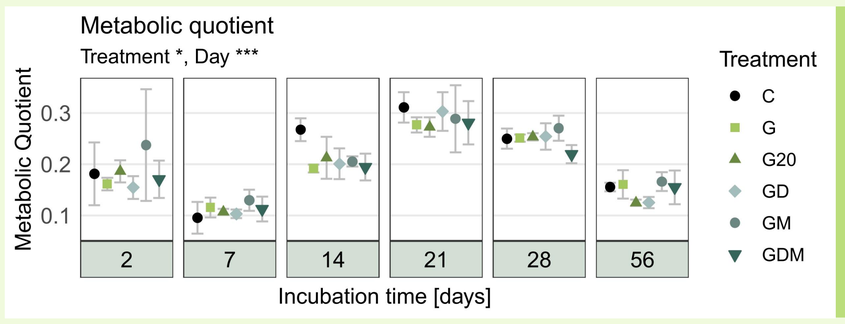
PPP 1 PPP 2 PPP 3

1. ^{13}C-Glyphosate (GLP/G) (Herbicide)*
2. MCPA (M) (Herbicide)*
3. Difenoconazole (DFC/D) (Fungicide)**

TREATMENTS

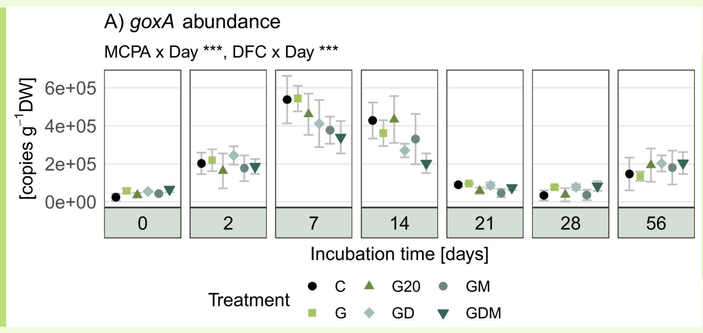


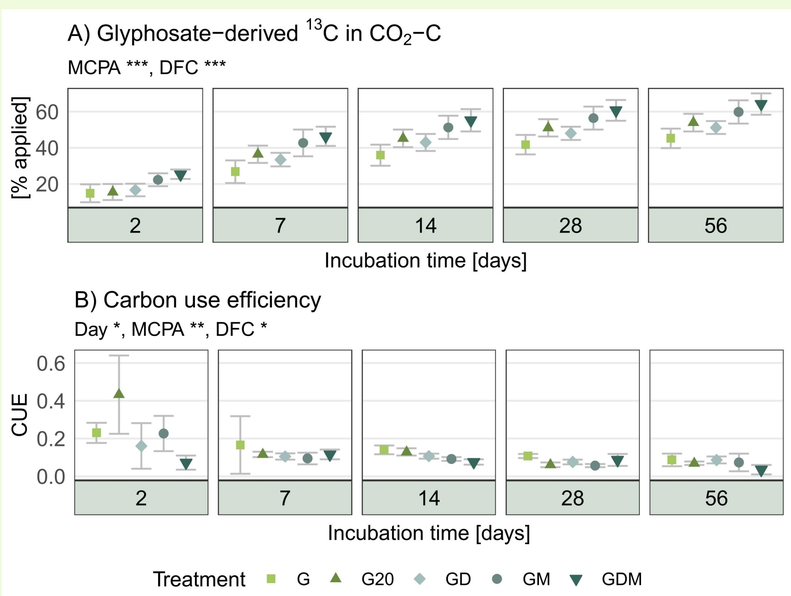
RESULTS AND DISCUSSION



Metabolic quotient initially increased by 35 %
→ MCPA induced **stress reaction**

Reduced genetic potential of GLP degradation via AMPA
→ Shift towards sarcosine pathway





GLP mineralization increased up to 40 %
→ Presence of MCPA can **increase bioavailability of GLP**, hence increasing the GLP mineralization

Carbon use efficiency decreased
→ **higher energy demand** in the glyphosate degrader community while limiting growth

EFFECTS OF PROSULFOCARB AND BOSCALID ON SUBSTRATE UTILIZATION AND SOIL MICROORGANISMS

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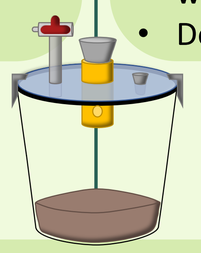
AIMS

- Investigate how quality of maize litter modifies the interactions of pesticides with soil microorganisms
- Determine how multiple pesticides affect microbial maize utilization



METHODS

✓ Pesticide residues ✓
✓ Respiration (microbial activity) ✓
✓ Chloroform fumigation extraction (microbial biomass) ✓
✓ Phospholipid fatty acid analysis (microbial community) ✓
✓ DNA extraction – Functional genes ✗
✗ Enzyme activities involved in C-, N- and P-cycling ✓

SETUP

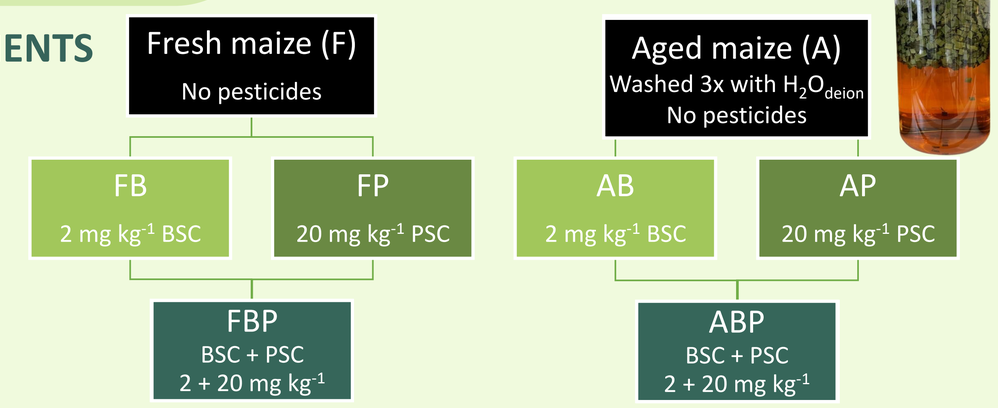
- Soil: Standard soil 2.2 from LUFA Speyer (loamy sand, pH 5.6, SOC 1.82 %)
- Pesticide carrier: Maize leaves (organic)
- Pesticide solvent: Acetone
- Incubation in microcosms (56 days, 20°C)

PESTICIDES

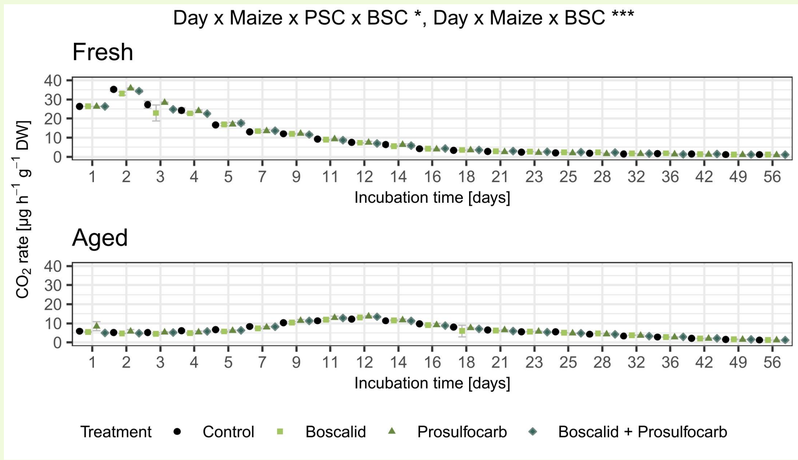
PPP 1 PPP 2

1. Prosulfocarb (PSC/P) (Herbicide)
2. Boscalid (BSC/B) (Fungicide)

TREATMENTS

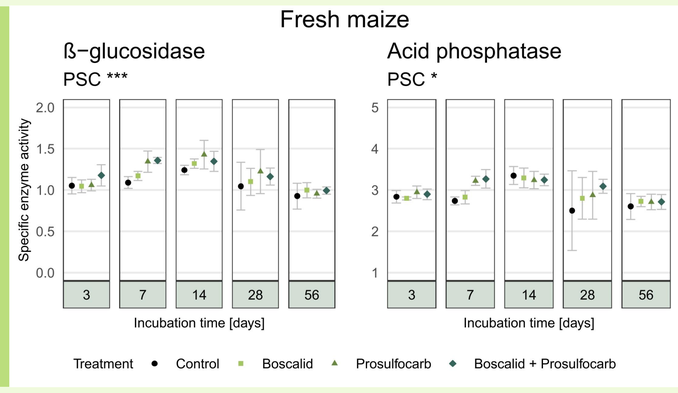


RESULTS AND DISCUSSION

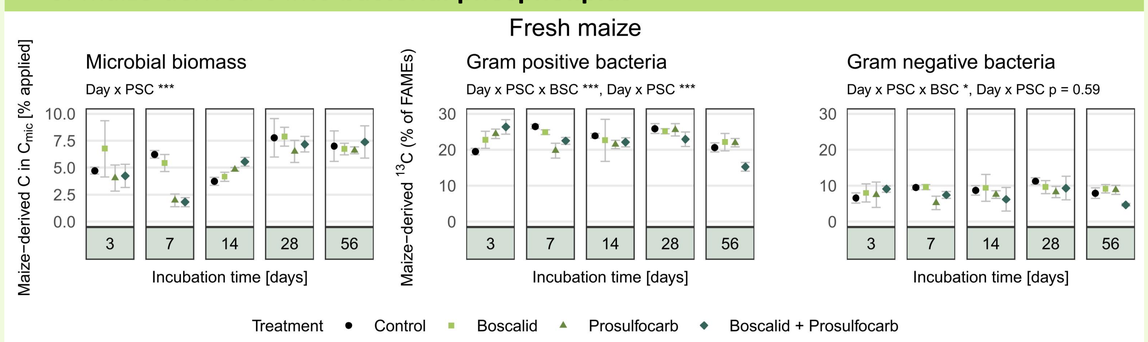


- Initial higher values in fresh maize treatments, delayed response in aged maize (e.g. respiration)
- BSC initially reduced respiration
  → acts as succinate dehydrogenase inhibitor, active against broad spectrum of fungi **inhibiting respiration**

PSC increased specific enzyme activities involved in C- and P-cycling
→ Nutrient acquisition strategy of soil microorganisms shifted towards more C and P that is needed for **maintenance mechanisms**



PSC decreased incorporation of maize-derived C into microbial biomass and bacterial PLFA
→ PSC acts as lipid synthesis inhibitor in plants and, in our study, **inhibits** incorporation of maize-derived C into **bacterial phospholipids**



CONCLUSIONS

- Pesticide mixtures can influence soil microorganisms in various **synergistic** and **antagonistic** ways.
- **Specific functions** of microorganisms such as pesticide and litter degradation can be altered in the presence of pesticides.
- Not only the number of pesticides present, but also their **individual effects** influenced the microbial community by **inducing stress** reactions or triggering **maintenance mechanisms.**

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References:
[1] Meidl, P., Lehmann, A., Bi, M., Breitenreiter, C., Benkrama, J., Li, E., Riedo, J., Rillig, M.C., 2024. Combined application of up to ten pesticides decreases key soil processes. Environmental Science and Pollution Research 31, 11995–12004. https://doi.org/10.1007/s11356-024-31836-x

The contribution of EK, CP, PM, ZB, JH, PH and FS was supported by funding from the EU Horizon 2020 research and innovation funding program under grant agreement No. 862568 (www.sprint-h2020.eu).