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Pesticide residues in bio-based fertilizer products – Assessing product safety by bioassays

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Methods

Plant growth test 1

- Clopyralid spiked in potting soil in 12.5, 25, 50 and 100 µg/kg concentrations
- Test species: Lentil (*Lens culinaris*) and Tomato (*Solanum lycopersicum*)
- Endpoints: germination, shoot growth and photosynthesis [pulse-amplitude-modulation chlorophyll fluorometry (IPAM-MAXI, Walz GmbH)] after 14 days

Plant growth test 2

- Clopyralid spiked in fertilizers, resulting in spiked concentrations of 25, 50 and 100 µg/kg in potting soil after fertilizing
- Test species: Lentil (*Lens culinaris*)
- Fertilizer types:
 - Chicken manure
 - Vinasse
 - Mineral fertilizer (only Control)
- Endpoints: germination and growth after 14 days

Springtail reproduction test

- Test species: *Folsomia candida*
- Concentrations: 0.01, 0.1, 1, 10, 100 and 1000 mg/kg in Lufa 2.2 soil
- Endpoint: reproduction after 28 days

Results

- Lentil (*Lens culinaris*) was more sensitive to clopyralid than tomato (*Solanum lycopersicum*) (Figure 1)
- No effects on photosynthesis [maximal photosystem II (PSII) photochemical efficiency (Fv/Fm) and operating efficiency of PSII Y(II)]
- Reproduction of springtail *F. candida* was not sensitive to clopyralid
- LOEC (Lowest Observed Effect Concentration)
 - Lentil growth: 50 µg/kg
 - Tomato growth: > 100 µg/kg
 - Springtail reproduction: 1000 mg/kg
- Growth inhibition of lentil was stronger when spiked in vinasse than in chicken manure, reflecting the high clopyralid background concentration of vinasse
 - Vinasse: 540 µg/kg (11.25 µg/kg in soil)
 - Chicken manure: < 1.0 µg/kg

Conclusions

- Use of herbicides can result in increased concentrations of herbicides in bio-based fertilizer products
- Growth of lentil (*Lens culinaris*) is sensitive indicator to detect clopyralid residues in fertilizer products

Highlights

- Raw materials of bio-based fertilizers (BBF) may contain pesticide residues, which can end up in the fertilizer products
- Bioassays were performed to detect herbicide clopyralid
- Lentil (*Lens culinaris*) was most sensitive species to clopyralid
- Exposure to clopyralid-spiked fertilizer products revealed the clopyralid residues in the fertilizer product

Introduction

Use of bio-based fertilizer (BBF) products support circular bioeconomy. However, the raw materials may contain pesticide residues, which can end up in the BBFs and pose negative implications to crops or soil biota. In this study, the sensitivity of two plant species and one soil invertebrate species to herbicide clopyralid was studied to find suitable indicators for clopyralid residue detection in BBFs to assess product safety. This study is part of project Kiertokas, funded by the Ministry of Agriculture and Forestry of Finland (Makera).

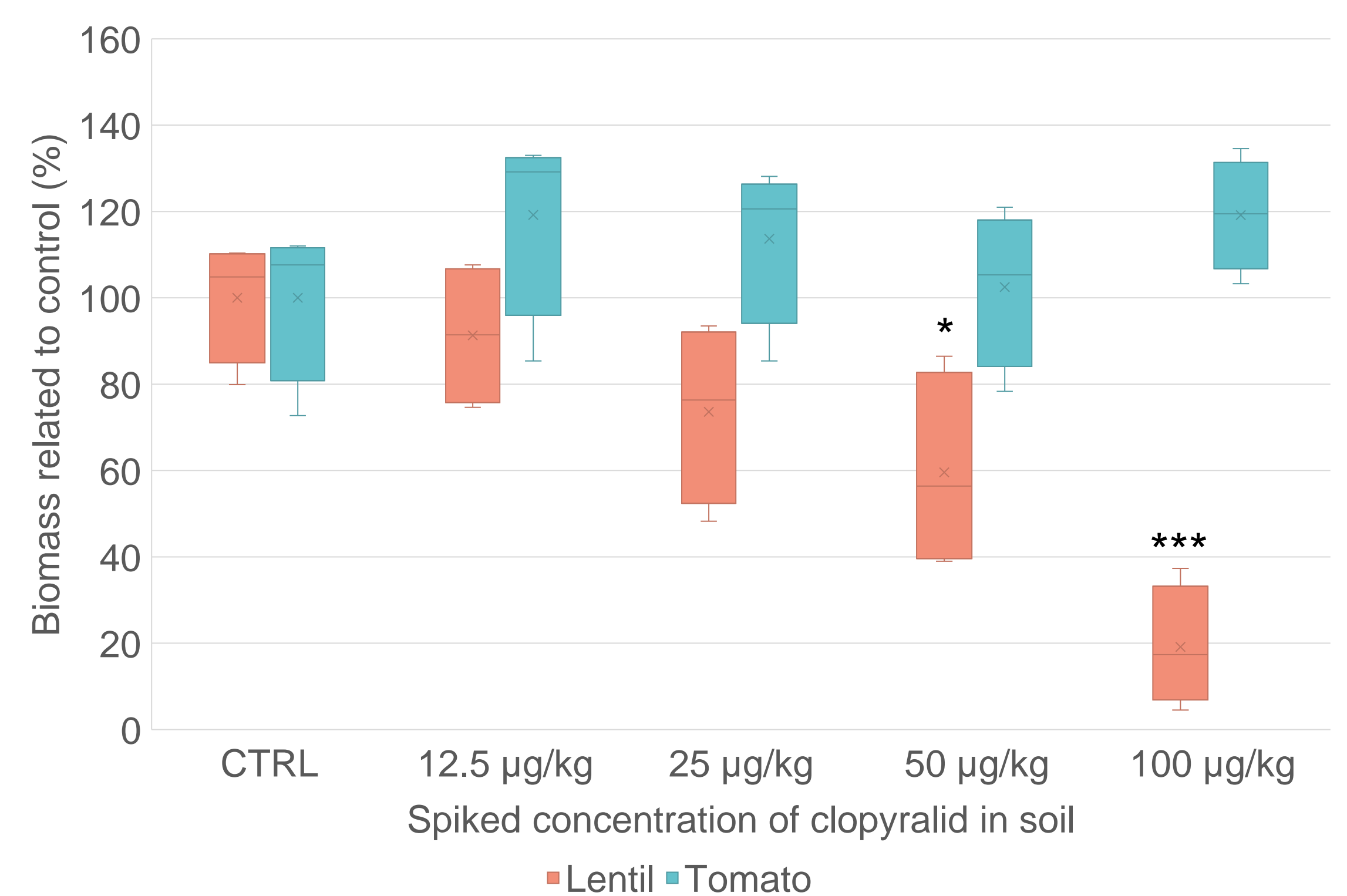


Figure 1. Biomass of lentil (*Lens culinaris*; red) and tomato (*Solanum lycopersicum*; blue) after 14 days of exposure to clopyralid. The asterisks show the statistically significant differences to the corresponding control.

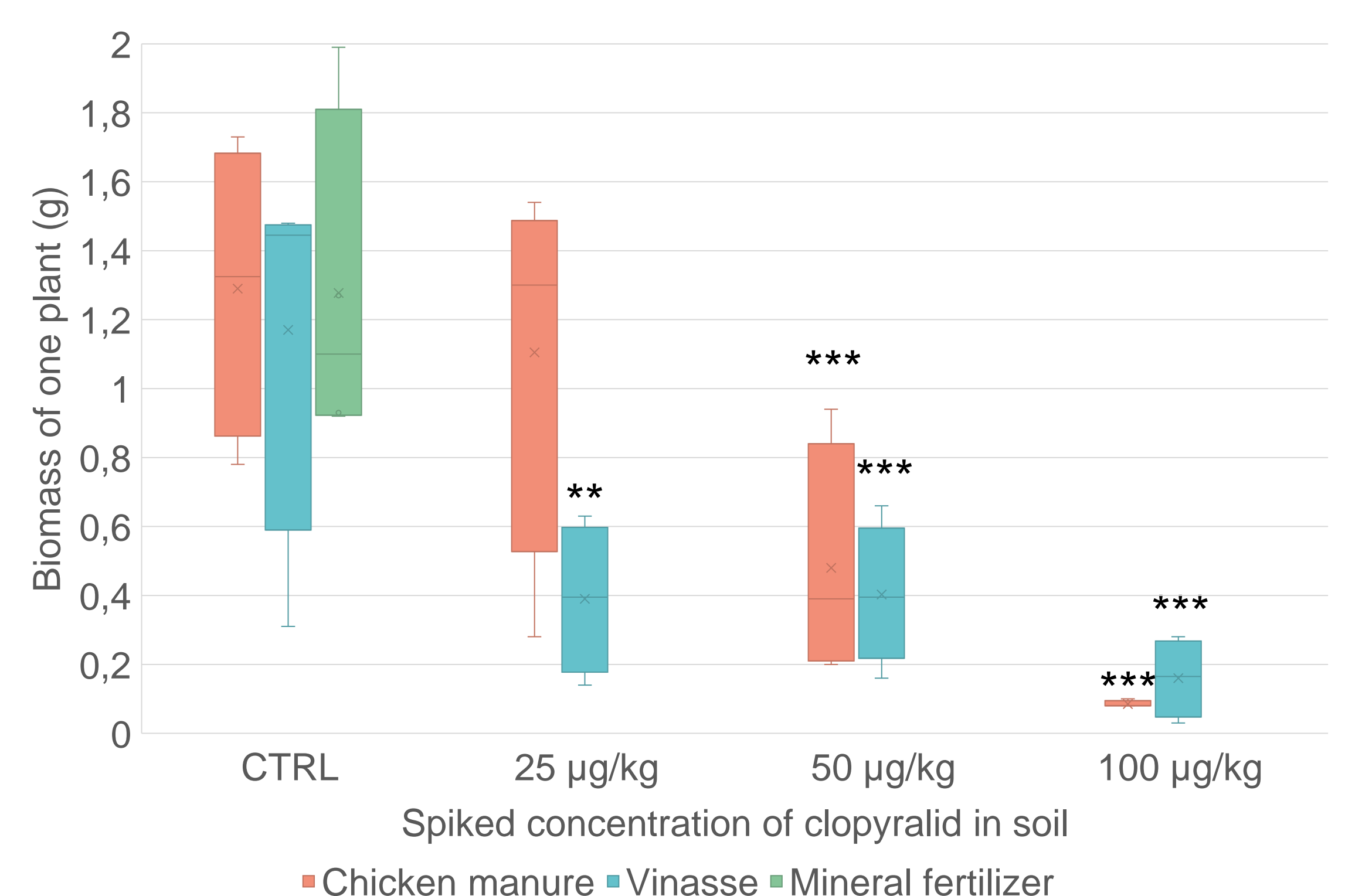


Figure 2. Biomass of lentil (*Lens culinaris*) after 14 days of exposure to clopyralid spiked in chicken manure (red) and vinasse (blue). Mineral fertilizer (green) was used as an additional control. The asterisks show the statistically significant differences to the corresponding control.



Plant growth of tomato (*Solanum lycopersicum*) exposed to 0, 12.5, 25, 50 and 100 µg/kg of clopyralid. © Anne Relander



Folsomia candida
 © Olli Leino



Growth of lentil (*Lens culinaris*) exposed to 0, 25, 50 and 100 µg/kg of clopyralid. © Anne Relander