Phytotoxic effects of microcystins on tomato seedlings (Solanum lycopersicum var. MicroTom) and soil microbial communities

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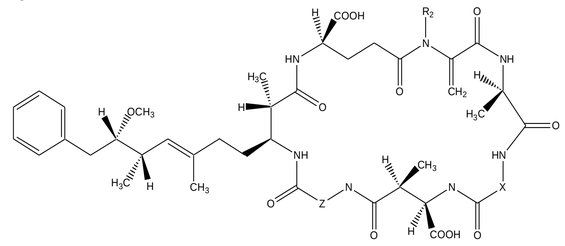
Introduction

The occurrence of harmful cyanobacterial blooms in surface waters is often accompanied by the release of cyanotoxins known as neurotoxins, dermatotoxins, and hepatotoxins. The presence of hepatotoxins of the microcystin type (MC), commonly found in surface waters, can induce adverse effects on aquatic ecosystems, human health, as well as socioeconomic disturbances. By contrast, little is known to date on the possible adverse effects of microcystins on terrestrial ecosystems. The main objective of this study deals with the study of toxic effects of microcystins on tomatoes seedlings (*Solanum lycopersicum* var. MicroTom) and on microbial communities of the soil. Toxins are provided to the soil by irrigation with contaminated water.

Cyanobacterial bloom

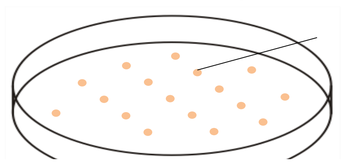


Structure of MCs

Materials and Methods

Microcystins (MCs) obtained from cultures of *Microcystis aeroginosa* (PCC7820, Pasteur Institute) amount to 6.78 mg equi MC-LR / g DW of cyanobacteria

Germination essays with toxic concentrations (0-20 mg equi MC-LR/L)



20 seeds/ Petri Dishes = replicate

Radicle lengths

3 replicates/treatments

350 g of dry sandy soil (2 mm)

3 replicates/treatments

Plantation
10 seeds/replicate

Exposition
Control
5 µg/L
20 µg/L
50 µg/L
100 µg/L

J0 — J15 — J30

Exposure
Moistened the soil
Daily Exposure

Harvesting of Plants
Dry weight

Harvesting of Soil
Potential nitrification
DNA quantification (Bacteria and Fungi)

Résults and Discussion

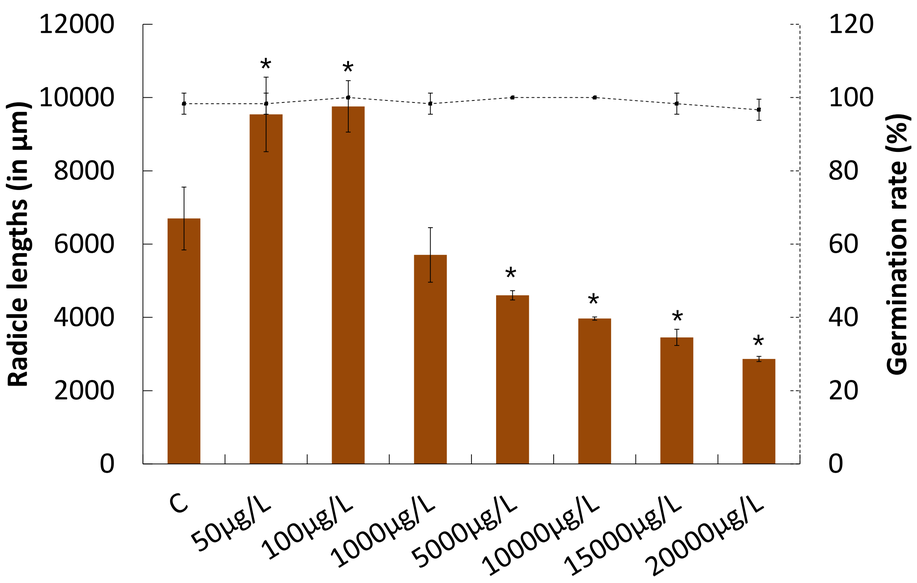


Fig. 1. **Germination rate of *S. lycopersicum* seeds and Inhibition growth of radicles after exposure to various concentrations of MCs**

The exposure of the seeds of *Solanum lycopersicum* var. MicroTom to irrigation water containing different concentrations of microcystins (0-20 mg eq. MC-LR/L) did not decrease its germination rate (**Fig. 1**).

Growth of radicles (**Fig. 1**) was significantly increased at low concentrations of microcystins (50 and 100 µg eq. MC-LR/L) and significantly inhibited at higher concentrations (>100 µg eq. MC-LR/L).

Microcystins are strong inhibitors of protein phosphatases in higher plant cells. They can disrupt at low concentrations absorption and transfer of nutrients or root phloem function, thus simulating additional root growth to compensate impaired root function.

Irrigation of the seedlings of *S. lycopersicum* by water containing different concentrations of microcystins (0-100 µg eq. MC-LR/L) showed no effects on root development, but dry biomass of aerial parts increased significantly (**Fig. 2**).

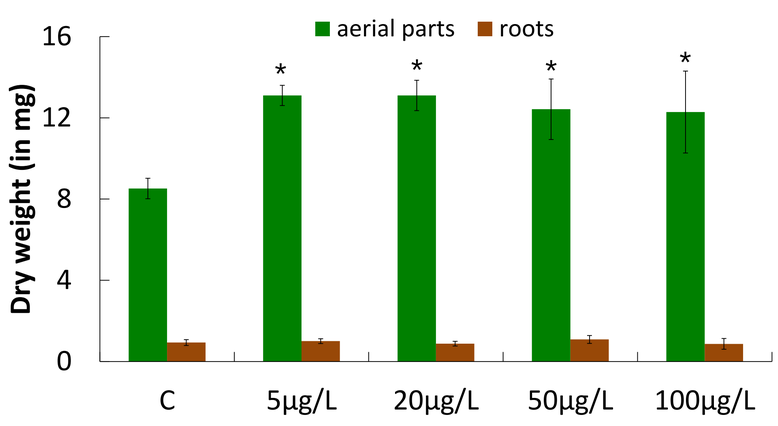


Fig. 2. **Dry weight of aerial parts and roots of *S. lycopersicum* seedlings after 15 days of exposure to various environmental concentrations of MCs**

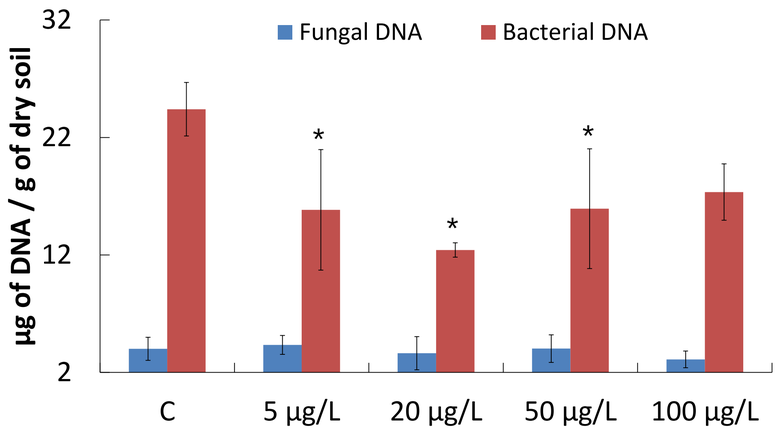


Fig. 3. **Quantification of fungal and bacterial DNA in soils after 15 days of exposure to various environmental concentrations of MCs**

Bacterial DNA amount was significantly decreased in the irrigated soil, but no effect was observed on fungal DNA level (**Fig. 3**), suggesting that only soil bacterial population seemed affected by MCs.

However, soil biological activity, such as nitrification was enhanced by microcystins at concentrations ranging from 5 to 50 µg/L. At the highest concentration (100 µg/L), no significant increase of nitrification was observed (**Fig. 4**).

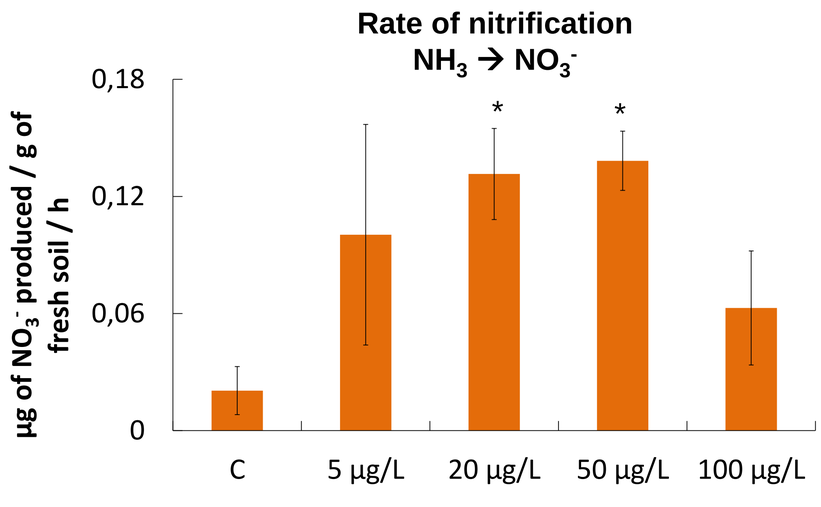


Fig. 4. **Rate of nitrification in soil after 15 days of exposure to various environmental concentrations of MCs**

Conclusions

Microcystins are known to affect many processes in plants. In the present study, we evidenced their effects on growth of radicles and seedlings of *Solanum lycopersicum* in soils irrigated with water contaminated with environmental concentrations of MCs. In addition, microcystins affect soil microbial communities by decreasing the size of bacterial populations and increasing the nitrification activities.

Acknowledgements

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