Fungal degradation of the phenylurea herbicides isoproturon, diuron, linuron and chlorotoluron

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Main findings
• The soil fungus Mortierella sp. Gr4 transformed all studied phenylurea herbicides by dealkylation and hydroxylation reactions.

Background
The phenylurea herbicides isoproturon, diuron, linuron and chlorotoluron have been extensively used in agriculture. The herbicides are degraded by microorganisms in soil, but both parent compounds and metabolites have been observed in surface and groundwaters in concentrations exceeding the drinking water threshold limit of 0.1 µg l⁻¹. The fungus Mortierella sp. Gr4 isolated from a Danish agricultural soil has previously been shown to demethylate and hydroxylate isoproturon.

Aims
• To investigate if the fungus Mortierella sp. Gr4 possesses a similar dealkylation and hydroxylation potential towards other phenylurea herbicides.
• To investigate the fungal transformation pathways and identify the metabolites produced.

Conclusions and perspectives
• Mortierella sp. Gr4 can perform several initial steps in the degradation of phenylurea herbicides. Both dealkylated and hydroxylated metabolites were observed.
• Linuron was the herbicide most rapidly transformed. The fungus performed both demethylation and demethoxylation in addition to hydrolysis of the carbonyl-bond yielding 3,4-dichloroaniline. Furthermore, a new linuron intermediate was observed.
• The methoxy-moiety of linuron might have a profound effect on the degradation when compared to the N,N'-dimethylated phenylurea herbicides.
• Next step is to identify the linuron-intermediate by NMR and MS.

Phenylurea herbicides

Experimental set-up
Herbicide amended mineral media inoculated with Mortierella sp. Gr4

Degradation of isoproturon by Mortierella sp. Gr4 – HPLC data

Degradation of linuron by Mortierella sp. Gr4 – TLC data

The proposed degradation pathway of diuron by Mortierella sp. Gr4

The proposed degradation pathway of chlorotoluron by Mortierella sp. Gr4

(Handouts)