Institute for Environmental Sciences, University of Koblenz-Landau, Campus Landau

Systemic Fungicides Can Alter the Quality of Plant Material for Aquatic Shredders

Kymberly Newton[1], Jochen Zubrod[1], Dominic Englert[1], Ralf Schulz[1] and Mirco Bundschuh[1,2]

[1] University of Koblenz-Landau, Campus Landau, Institute for Environmental Sciences, Landau, Germany

[2] Swedish University of Agricultural Sciences, Department of Aquatic Sciences and Assessment, Uppsala, Sweden

Correspondence: newt7693@uni-landau.de

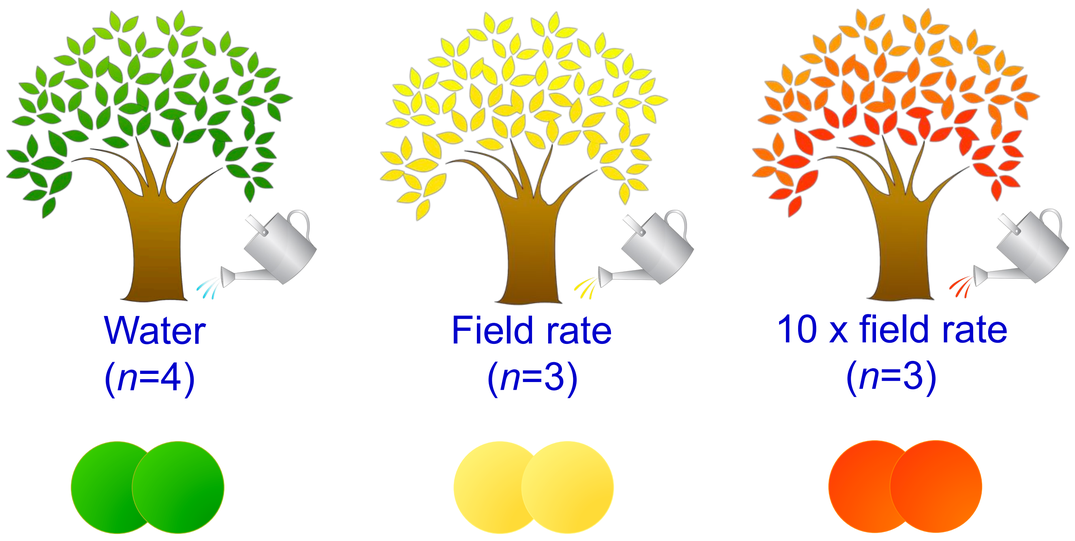
Introduction

Leaf-litter breakdown is an essential function in stream ecosystems [1]. However, the microorganisms and invertebrates (i.e. shredders) involved in this process react negatively to waterborne fungicide exposure [2,3]. Systemic fungicide exposure (i.e. plant material containing the fungicides), on the other hand, has not yet been examined. Therefore, we assessed systemic fungicides' effects on the food quality of leaf material for the amphipod model shredder *Gammarus fossarum*.

Material & Methods

Fungicide application

To assess this exposure pathway's effects, we first subjected *Alnus glutinosa* trees ($n \geq 3$; Fig.1) to irrigation with fungicide-free water, a mixture of four systemic fungicides at recommended field rates, (azoxystrobin = 200 g/ha, cyprodinil = 400 g/ha, quinoxyfen = 100 g/ha, and tebuconazole = 200 g/ha [5]), and at rates 10-time the field rates. Starting mid-July, the fungicides were applied twice, with a six-week interval. Leaves were picked from the trees six weeks after the last application (in October) and frozen.



With Microbial Conditioning

To assess the potential for a fungicide-induced shift in the leaf associated microbial community (e.g. fungi), which is hypothesized to affect the feeding preference of *Gammarus* indirectly, part of the leaf discs were subjected to colonization by a natural microbial community for 13 days (=conditioning). As a key determinant of food quality of leaves for shredders [5], fungal biomass of the leaf material (measured as ergosterol) was quantified in the leaves after conditioning.

Without Conditioning

Unconditioned leaves were used to check for relevant deviations in leaf quality as a result of the fungicides taken up by the trees during growth.

Gammarus fossarum food-choice trials

24-h food choice tests were run offering leaves from trees treated with fungicide free water or one of the fungicide treatments.

Fig.1. Experimental tree nursery.

Results & Discussion

Gammarids significantly preferred microbially conditioned leaves that were treated with ten-times the recommended field rate over control leaves (paired *t*-test; P=0.02; Fig. 2a), which is contrary to what can be observed when leaves are exposed to synthetic fungicides during microbial conditioning via the water phase [2]. This effect could neither be explained by fungicide-altered leaf characteristics already present before microbial conditioning as food choice trials with unconditioned leaf material did not result in any significant preferences. Nor did the leaf-associated fungal biomass (Fig. 2b) indicate a higher quality of leaf material treated with ten-times the recommended field rate. We nonetheless, hypothesize that there is a possibility of a fungal community shift, which according to literature, seems to be more important than the total fungal biomass [6]. Further analyses on leaf stoichiometry and the structure of the leaf-associated microbial communities are underway to clarify the observed indirect effect. Nonetheless, we can conclude that systemic fungicides have the potential to affect the palatability and thus probably the nutritional quality of leaves, which may have far-reaching consequences for detritus-based food webs receiving such material.

Acknowledgements

Nadja Schnetzer, Simon Klöttschen, Simon Lüderwald, Theresa Schell, and Marco Konschak are acknowledged for their support in the laboratory.

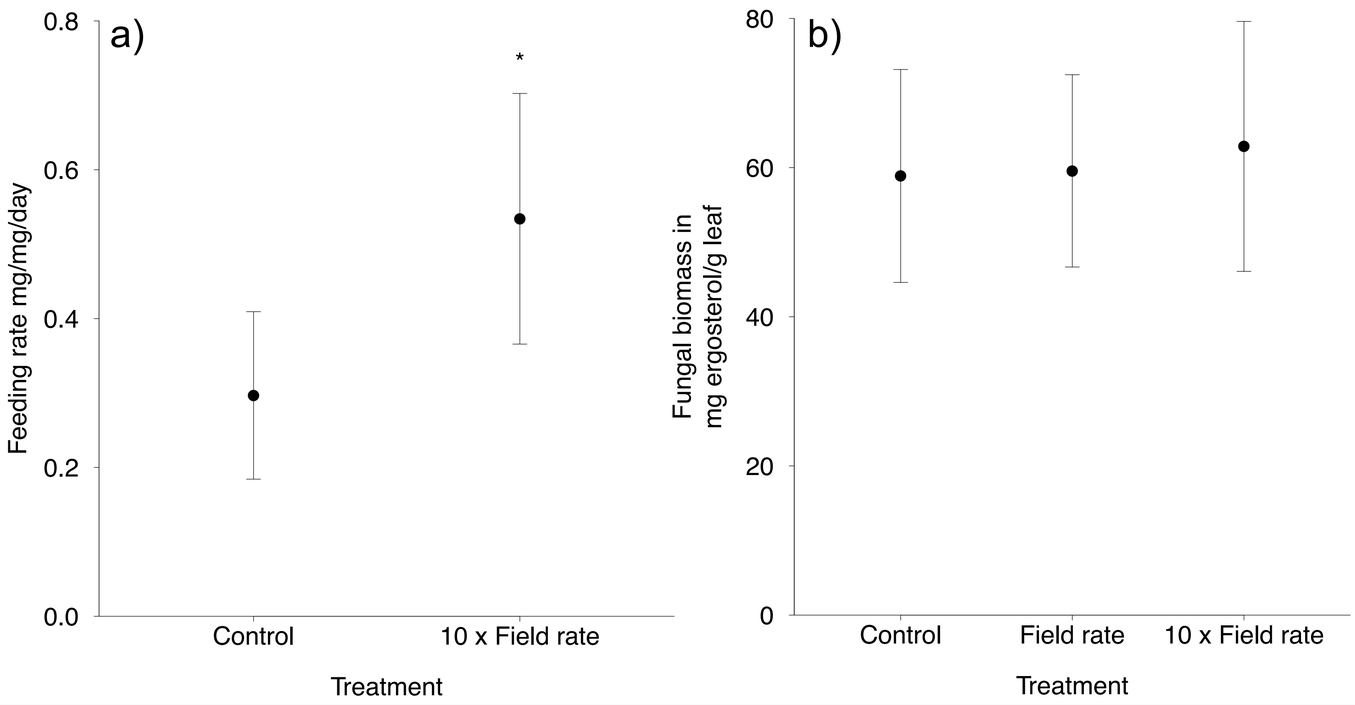


Fig. 2. a) Mean feeding rate of G. fossarum *given the choice to feed on high fungicide treatment leaf discs. b) Leaf-associated fungal biomass of the non-treated control, the low fungicide treatment, and the high fungicide treatment. Asterisk (*) indicates a statistically significant difference.*

References

[1] Hieber and Gessner. 2002. Ecology 83:1026–1038.

[2] Zubrod et al. 2015. ES&T. 49, 1173-1181.

[3] Zubrod et al. 2011. ET&C. 30, 2718–2724.

[4] Das BVL. 2014. Pflanzenschutzmittel-Verzeichnis.

[5] Foucreau et al. 2013. Freshwater Biology. 58, 1672-1681.

[6] Bundschuh et al. 2011. Aquatic Toxicology. 104, 32-37.